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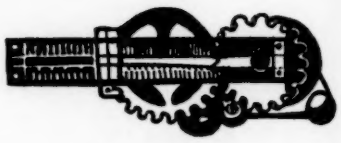
SCIENCE AND THE SPIRIT OF MAN



David E. Lilienthal

SCIENCE and technology were once matters which concerned only those with special technical knowledge; today they are front-page news, affecting men's daily lives and daily decisions. Whether millions of human beings shall go hungry or be fed, shall suffer disease or enjoy good health, be condemned to drudgery or use machines to relieve their toil—more and more such human questions are determined by modern technology. Even more than this: technology and the machine have become central figures in the perilous struggle to safeguard the free spirit of man and to establish a peace that is a true peace.

The American people have asserted and strengthened their historic role of maintaining the offensive in the ceaseless contest for men's minds and loyalties, with the most potent weapon ever devised, a weapon that makes the atomic bomb seem a firecracker by comparison: an idea. That idea is this: that technology applied for human welfare can not only bring material well-being but can also nourish the free spirit of man.

The towering place of the machine, of science and the technical skills that create the machine, are among the dominant facts of the turbulent times in which we live. The President's bold "new program," the activities in our atomic laboratories, the new advances in medicine, in the production of food by scientific methods, in the design of new scientific weapons of vast destructiveness—these and many other instances can be cited of the predominant position of science and engineering today. And from such facts the great issue of our lifetime emerges. It is an issue with which you and I and all the peoples of the world will be at grips, day in and day out, for the rest of our lives. It is this:

Are machines and science to be used to degrade man and destroy him, or are they to be used to augment the dignity and nobility of humankind? How can men use science and the machine to further the well-being of all men and the flowering of the human spirit?

From this issue no one who lives today can escape. It reaches into the lives of every one of us, old and young, rich and poor. It concerns the housewife, the librarian, the chemist; it must be faced by the clergyman, the professor, and the physician no less than by the businessman and the public official. For this is the kind of world we live in—the world of the machine—and this is the struggle of our time.

Standing always at the elbow of each delegate at the United Nations Security Council meetings, always present at the conference tables of this troubled world is this same issue: how is technology to be used? Cross the seas and the shadow of this question has preceded you—to the valley of China's Yangtze River, to the rising factories of Bombay, to the oil fields of Iran, the tractor-powered wheat farms of the Ukraine. Geography and language differ, but the question and the struggle are everywhere in essence the same.

Men ask themselves: Is our advancing technology good? Is the ever more important machine good? Or are they evil?

To some people modern technology is plainly evil. To them the more gadgets the more unpalatable is life. The more things we produce, the faster we can travel, the more complex the machines we invent, the nearer—they assert—we move to the edge of a bottomless pit. They ask: "Is not scientific warfare the inevitable fruit of technology? Are not ever more devastating atomic bombs the ultimate proof that modern applied science is a curse, an unmitigated blight?" Even great figures are heard to say: "Let us cease learning more of the world, let scientists declare a moratorium on their ceaseless prying into Nature's secrets." They are homesick for that simpler life, before the days when man produced so much and knew so much. They want to flee. But where and how? They cannot say. They cry out against science and the machine and call them evil; but their voices are the voices of despair and defeat.

There are others of our contemporaries who have an almost opposite view of the machine. You will find them all over the world. What they say is exuberant and uncritical. "Of course technology is good," they say, "for it produces more and more things; and isn't production the answer to everything?" They are usually skeptical of God, but they openly worship the machine.

"Of course the machine is good," they say. "When assembly lines cut costs, when production curves are upward or when Five-Year Plans are fulfilled—those are the important things; let's not agonize over the effect of the machine on the freedom of men."

Technology, they seem to say, is good as an end in itself. If the spirit of man balks, if the yearning to be human increases cost of production or requires coercion—well, man must be redesigned to fit the assembly line, not the assembly line revised for man. The supertechnologists of the world are quite prepared to recreate man in the image of the machine.

I venture to say that neither of these views—of the defeatist or the technolator—will appeal to most Americans.

The machine and technology are neither good nor evil in themselves. They are good only when man uses them for good. They are evil only if he puts them to evil purposes.

The machine can, of course, be so used as to degrade and enslave man. It can be used to exhaust the land and with it the human dignity of those who live on the land; it can poison the air, foul the streams, devastate the forests, and thereby doom men and women and children to the spiritual degradation of great poverty. But it can also open wider—and it has so opened—the doors of human opportunity; it can nourish the spirit of men. Technology can be used to eliminate filth and congestion and disease; to strengthen the soil; to conserve the forests; to humanize man's environment.

The machine can be so used as to make men free as they have never been free before.

WE HAVE a choice—that, it seems to me, is the shining and hopeful fact. If we are wise enough, if we follow our democratic precepts, we can control and direct technology and the machine and make them serve for good.

I believe in the great potentialities for well-being of the machine and technology; and though they do hold a real threat of enslavement and frustration for the human spirit, I believe those dangers can be averted. I believe that through the methods of democracy the

An address given at Lehigh University, Bethlehem, Pennsylvania, on February 6.

world of technology holds out the greatest opportunity in all history for the development of the individual, according to his own talents, aspirations, and willingness to shoulder the responsibilities of a free man. I believe men can make themselves free. Men can direct technology so that it can carry mankind toward the fulfilment of the greatest promise for human life and the human spirit in all history.

But this result is by no means inevitable. It is equally possible that technology may yield a harvest of bitter fruit.

More huge cyclotrons and nuclear research reactors are not enough. More fine laboratories, more extensive projects in physical and social research are not enough. More *use* of technology, more factories, more gadgets, whether in this country or in the undeveloped reaches of Africa and Asia and South America is not enough. Those who encourage a contrary belief are playing a dangerous game or are quite blind to the realities.

UNLESS the applications of research and technology are consciously related to a central purpose of human welfare, unless technology is defined and directed by those who believe in people and in democratic and ethical ends and means, it could be that the more research money we spend the further we miss the mark. It is like driving in an automobile that is going in the wrong direction; the faster you drive the farther away from your destination you will be.

The guiding of technical activity is safe, in terms of the human spirit, only when it is in the hands of those, in private business and in public agencies, who have faith in the individual human being. It is only safe when it is carried on by methods that are in furtherance of that faith, and methods that insure accountability to the people for the results.

This is not always the case with modern technology. There are times when these matters are controlled by men who lack a faith in people. People, to them, are only a "market." They are a market to whom to sell new gadgets; a labor market with which to make the gadgets; a political market to be cajoled and organized and voted and coerced. Technical development under such direction will not further freedom or will do so only by accident, by sheer coincidence.

We know what amazing things applied research can do to increase the destructive powers of Armies and Navies and Air Forces—our own, or a potential enemy's. But we still must ask: What can technology do to nourish and strengthen the human spirit? What can technology do to safeguard and strengthen men's freedom?

That modern man can completely change his environment is a matter of common observation. Perhaps as widely known an illustration in other parts of the world is afforded by the development in the Tennessee Valley.

In a single decade the face of a region larger than England was substantially altered, a region comprising parts of seven Southern states. The great Tennessee River has been changed: more than a score of huge dams make it do what men tell it to do. The farming land is changed—millions of acres—and the forests and woodlands. New factories, large and small, barges on the new river channel, and yards building ships; fields once dead and hideous with gullies now fruitful and green to the sun, secure with pastures and meadows; electric pumps in farmyards; new local and regional libraries; state parks and county health facilities—these and many other changes make it a new Valley today. The job of development is not done, of course—such a task never is—but it is well on the way. It is one more demonstration that modern technical tools and managerial skills can control Nature and change the physical setting of our life in almost any way we choose—there is the point—in whatever way we as a people choose.

These changes in that Valley—these physical changes—strike the eye. They are unmistakable evidence of what can be done. Equally impressive are the evidences of increased production of farm and factory, of rising individual income among people who have suffered under shockingly sparse incomes. But most important of all the changes is the change in the spirit of the Valley's people. One of Alabama's younger leaders described it in these words: "We can write of great dams . . . of the building of home-grown industry and of electricity at last coming to the farms of thousands of farm people in the Valley. Yet the significant advances have been made in the thinking of a people. They are no longer afraid. They have caught the vision of their own powers. They can stand now and talk out in meeting . . ." And they do!

THE REAL significance to many observers of what has taken place in the Valley of the Tennessee is this: This American experiment has fortified confidence that men need not be chained to the wheel of technology. If their purpose is firm and clear, and if they insist upon ways and means to make that purpose effective, man can use the machine in the interest of human welfare and the human spirit.

A great many men and women from foreign countries have come to study the TVA. They have come from more than 50 countries, and in particular from the technically undeveloped regions of the world, and from areas in which unsparing and unwise exploitation threatens their natural resources with utter exhaustion. These visitors have not only seen new life come to a dying soil; they have also seen how a new hope and faith return to people living on that soil, have seen men's pride and their human dignity strengthened as their soil was strengthened. They have not only seen the once wasted energies of a great river turned into electricity but they have also seen the way that electricity has put an end to degrading drudgery in tens of thousands of homes. They have seen businessmen, farmers, laborers—all kinds of men and women—joining together to apply the lessons of science and technology to the building of their region, and in the very act of joining together for that common purpose have seen many of them become better neighbors, kinder and more generous and more cooperative human beings.

These hundreds of foreign visitors see with particular clarity that the new

In This Issue

Science and the Spirit of Man 98
David Lilienthal

The Los Alamos Scientific Laboratory 101
J. H. Manley

Secretary Forrestal's Statement on Biological Warfare 104

Freedom of Science 106

Joliot-Curie and the Atomic Secrets 109

Planning for Civil Defense 111
Russell J. Hopley

Chart: AEC Organization and Personnel 112

AEC Fifth Semiannual Report: Part II 114

Letter to the Editors 127
Zenas L. Potter

"No Place to Hide" 128
reviewed by Austin M. Brues

Tennessee Valley speaks in a tongue that is universal among men, a language of things close to the everyday lives of people: soil, forests, factories, minerals, rivers. No English interpreter is needed when a Chinese or a Hindu or a Peruvian sees these products of a working technology, sees a series of working dams, or a hillside pasture brought back to life by phosphate and lime and an understanding of soils. For it is not really Fontana Dam on a North Carolina stream or a farm in Kentucky that he sees, but a river, a valley, a farm in China or India or Peru.

BECAUSE it is an illustration with which I am familiar, I have pointed to the Tennessee Valley as one bit of American evidence that *it can be done*, that men can use science and technology in the interest of the human spirit. It does not make the demonstration less relevant that only a beginning has been made in that Valley, that the people of the Valley realize what a long, long way there is yet to travel. And surely it should not be necessary to utter the warning that no one should regard the TVA, or any other one effort in this direction, as a single way out. The paths are many, and TVA is but one of the many moving toward the same goal.

We have a choice. We can choose deliberately and consciously whether the machine or man comes first. But that choice will not be exercised on a single occasion, surrounded by spectacle and drama. We will move from decision to decision, from issue to issue, and all of us will be in the midst of this struggle for the rest of our days.

We cannot master the machine in the interest of the human spirit unless we have a faith in people. This is the foundation of everything. The rock upon which all these efforts rest must be a deep and abiding faith in human beings, which is a faith in the supreme worth of life. The machine can only add to the dignity and integrity of human existence if it is deliberately used in furtherance of such faith in people. It is the purpose for which the machine is used, and particularly the methods pursued in carrying out that purpose that determine whether technology is likely to further human well-being or to threaten it.

Let me restate: We do have a choice. On the one hand, it is clear that science in the hands of those seeking arbitrary power over men can make us slaves—well-fed perhaps, but more pathetic for that fact. On the other hand, it is plain that men can use technology and the machine to further human freedom and the development of human personality.

How the machine shall be used will be determined by choices made by the people. But those choices are genuine choices only if the people make them with a knowledge of the facts, with a knowledge of the alternatives that are open to them. The means whereby the people make their decisions depend upon a sacred and inviolable process—the dissemination of knowledge.

One such recent choice was the decision of the American people, through their elected representatives, in favor of civilian as distinguished from military direction of the scientific and technical development of atomic energy. After months of hearings and extended public discussion, Congress decided that, although atomic energy is of central importance to the national defense, it also holds such broad implications for our health, agriculture, industry, education—in short our whole way of life—that it must be fitted into the democratic scheme of civilian self-government.

That was an important decision. But many other questions concerning atomic energy are before this country today, and many more will arise in the months and years ahead.

These questions concern every last one of us. They include such questions as these: What kind of Army, Navy and Air Force do we now require, in the light of these new discoveries? What are safe and what are unsafe methods of international control of atomic energy to prevent its use as a surprise weapon? How extensively should the American people support medical research in this field, and similarly research in nutrition and in increasing the production of food by novel methods opened up by these new developments? What should be the place of private corporations in this brand-new technology, an industry that unlike anything the world has ever seen before was a giant at birth, and wholly government-owned? How do the people see to it that our universities and research institutions shall remain free of Government or military control when it is necessary that such vast sums for research and development be provided to them by the Federal treasury? How can the people see to it that narrow politics and pork barrel methods are kept strictly out of this huge scientific, industrial and educational enterprise? How can we maintain essential secrecy without drying up the very well-springs of scientific and technical advance, which flourishes not in secrecy but in openness and free discussion?

THE questions are manifold. The answers, the decisions, will affect directly the future well-being of the 145,000,000 stockholders in this atomic enterprise, that is, the people of the United States. They will indeed affect every human being on the globe.

Those decisions to be genuine democratic decisions require facts in the hands of the people. Indeed facts and the dissemination of knowledge are the very foundation of self-government, are the very foundation of any effort to direct technology toward the protection of the free spirit of man.

Because of its military aspects and the present unhappy international situation, it is not possible to make the whole atomic energy field subject to public scrutiny. But as we on the Commission have studied the matter, we have found that much of what is going on in this strange new enterprise can with safety be publicly reported and publicly discussed. One such report was recently issued. More reports, ranging from an Atomic Primer to an Atomic Weapons' Effects Handbook, are in preparation.

Wide dissemination of facts and broad public discussion in this field must continue and must increase. For unless the people have the essential facts about atomic energy they cannot act wisely nor can they act democratically.

It is well that we recall our basic tenet: that this democracy of ours is founded upon a faith in the judgment of the people as a whole. It is founded upon a belief that when the people are informed — honestly and clearly informed — their conscience and their common sense can be relied upon to carry us safely through any crisis. The direction of applied science and the machine by the judgment and conscience of the people as a whole requires that we be an informed people.

Faith in the people must have as its corollaries, faith in the facts, faith in the power of knowledge, faith in the free flow of ideas, and hence faith in education and the processes of education. These are the very pillars of our free society.

THE LOS ALAMOS SCIENTIFIC LABORATORY

J. H. Manley

This description of the activities of the Los Alamos Laboratory, written by its Technical Associate Director, is the second article in the series on AEC laboratories which the editors hope to continue in subsequent issues. An article on the Argonne National Laboratory by Farrington Daniels appeared in the June, 1948, **Bulletin.** Dr. Manley was active in the establishment of the Los Alamos Laboratory and has been connected with it almost continuously since 1943. He is also secretary of the AEC General Advisory Committee.

THE Los Alamos Scientific Laboratory was established in April, 1943, at the Los Alamos Ranch School, about thirty-five miles from Santa Fe, New Mexico. This school was taken over by the Manhattan Engineer District, which constructed the laboratory, housing, and community facilities, and provided maintenance and operation. The Laboratory proper was then and is now operated under contract by the University of California. Dr. J. R. Oppenheimer was director of the Laboratory from its inception to October, 1945, when he was succeeded by Dr. N. E. Bradbury, the present director.

The initial technical personnel and considerable equipment were supplied by the consolidation of numerous separate contracts with such organizations as Cornell, Princeton, Purdue, Rice, Carnegie Institution, and the universities of California, Chicago, Minnesota, and Wisconsin. These contracts, which had been established to carry out experimental and theoretical work leading to the military utilization of atomic energy, had been directed by J. R. Oppenheimer and J. H. Manley.

Although Los Alamos was initially planned as a small laboratory community of less than one hundred scientists and their families, the nature of the work and the desirability of concentrating all activity at one location, rather than depending upon the support of numerous outside organizations, led to an expansion such that the wartime peak was nearly 3,000 workers engaged in the technical operation of the Laboratory and the supporting services. At present this number is about 1600 at Los Alamos proper and 1400 at the Sandia Branch of the Laboratory.

Sandia Branch of the Los Alamos Scientific Laboratory was originally organized to provide contact with the Armed Forces at Sandia Base, near Albuquerque, and to handle certain engineering features of the atomic bomb. In the course of time, more and more of the ordnance engineering aspects of the weapon have been transferred to Sandia, and in the summer of 1948 that Laboratory was established as a branch of the Los Alamos Scientific Laboratory under the direction of Paul J. Larsen. Its present responsibilities include the research and development of fusing systems, design and testing of ballistic shapes, production engineering of parts and complete units, surveillance and storage, training of Armed Services personnel, and liaison with the Armed Forces.

Los Alamos proper devotes its facilities to research and development on the more fundamental problems relating to the use of nuclear energy for explosive purposes, relying on Sandia Branch for those functions closer to the ordnance aspects of nuclear weapons. In addition to the general supervision of the Sandia Laboratory, Los Alamos also has responsibility for another detached location — the Pacific Proving Ground, maintained by the Atomic Energy Commission on Eniwetok Atoll. This area is not maintained for routine test of weapons in the usual proving-ground sense, but is a location at which laboratory-type experiments can be carried out which, for several reasons, cannot be performed in more habited areas.

FUNCTION OF LOS ALAMOS LABORATORY

THE utilization of nuclear energy for explosive purposes involves several areas of knowledge:

1. The nuclear characteristics, especially with respect to neutrons, of all materials which are employed;
2. The physical, chemical, and metallurgical characteristics of these materials;
3. The mechanics and dynamics of methods of initiating the nuclear energy release;
4. The behavior of supercritical[1] systems in which the energy generation per unit volume is very large.

[1] In a "supercritical" system, if fission is started, its rate will rise, whereas in one which is "subcritical" the rate will fall and the chain reaction will eventually cease.

Each of these areas corresponds in a general way to an organizational division of the Laboratory, with the Theoretical Division involved in all areas, especially the last, which is understandably less amenable to experimental investigation than others.

The Physics Division, with its cyclotron, Van de Graaff generator, Cockcroft-Walton accelerator, betatron, and associated equipment, is primarily a nuclear physics research organization with responsibility for the first area.

THE Chemistry and Metallurgy Division carries on research on the exotic materials used in the arrangements for producing a nuclear explosion. It must develop processes for fabrication of these materials, for their adequate purification, and carry out pilot-plant operations on a production scale adequate to insure continual improvement in process know-how.

The third area is the responsibility of a Weapons Division and of another division concerned with assembly problems.

The fourth area includes not only the Theoretical Division but also a Test Division, responsible for nuclear measurements in actual tests.

The Theoretical Division, in addition to being well equipped with pencils, paper, and hand-computing machines, possesses such auxiliary devices as a battery of International Business Machines, and from time to time makes demands on the services of electronic computers such as the Eniac at the Aberdeen Proving Ground. Its problems range from those of fundamental theoretical nuclear physics and particle interactions to the behavior of gross matter under stellar conditions.

The theoretical behavior of a nuclear explosive rests on an understanding of three coupled areas: neutronics, hydrodynamics, and radiation. The neutron behavior of a complicated system of

active and inert material must be followed through the assembly process from a subcritical to a supercritical configuration, then on into the phase of rapid energy generation. This energy generation produces phenomena in which pressures are discussed in units of millions of atmospheres, temperatures in millions of degrees, and times in millionths of a second. It is therefore clear that the Laboratory must place great reliance on theoretical calculations in these areas normally inaccessible to experimental techniques and is continually placing before the experimenters a strong challenge to devise ingenious ways of checking at least segments of the theoretical predictions.

IN ORDER that theorists have appropriate numbers by which equations governing neutronic behavior can be related to quantitative reality, the Physics Division, with its naturally radioactive sources, its accelerators and its reactors, plus counters, chambers, and electronic gear, must make measurements of nuclear reaction constants over most of the periodic table. Even if an element is not directly employed as part of the explosive system, it may have useful properties as a detector of radiation involved in such a system. For example, the betatron has proved particularly useful in exploring (gamma, n) reactions which, through their relations to (n, 2n) reactions,[2] provide possibilities of threshold neutron detectors for investigating the energy-distribution of neutrons.

In addition to the usual accelerating equipment, the Physics Division operates two chain reactors. The "water-boiler" is a reactor which contains a solution of enriched uranium surrounded by a suitable reflector. Since it is the only chain-reacting system of this type in existence, its construction, operation, and behavior have contributed to knowledge and experience relating to possible reactors. Because of its relative simplicity compared to reactors using natural uranium, reactors of this type are of general interest as research tools. It supplies a steady, controllable neutron flux of known magnitude which is useful for a variety of purposes ranging from fundamental neutron experiments to a method of weighing minute quantities of fissionable materials by fission counting a sample in a standard flux.

The "fast reactor" is a critical assembly in which the fissionable material is plutonium metal. The assembly involves no light elements; hence the neutrons which maintain the chain reaction are "fast," much as in a nuclear explosive. These two features—use of plutonium and of fast neutrons—are novel in reactors. Although this reactor has obvious value to the main line of interest of the Laboratory, its characteristics are closely related to two trends in the general field of reactor development—toward units sustained by fast neutrons, and toward units operating with plutonium as the fuel.

The first is stimulated by the hope of decreasing the amount of parasitic[3] neutron capture which exists in thermal reactors and is being exploited at Argonne National Laboratory and at the Knolls Laboratory of the General Electric Company. In fact, specific measurements have been made with the Los Alamos reactor in order to assist Argonne in the design of reactors under development there.

The second trend is stimulated by the hope that it will be possible in an appropriate reactor to create more fissionable material than is consumed—the so-called "breeding" possibility. Experience at Los Alamos with the fast reactor will undoubtedly provide some of the basic information for this kind of future development.

SINCE it is well known that nuclear energy can be released not only through the fission process but also in light element reactions, the Physics Division has an experimental program which is not restricted to phenomena connected solely with fission and neutrons, but includes the study of reactions between the light elements. Research in this field is of interest not only because nuclear energy is released in such reactions but because detailed knowledge of these reactions can contribute in a fundamental way to the development and understanding of nuclear physics itself.

The techniques of nuclear physics with respect to the measurement of reaction cross sections,[4] for example, have not advanced to the degree of precision which characterizes such a field as spectroscopy. Even with the best measurements available, it is not possible to predict with adequate accuracy the behavior of an experimental system of modest complexity. Much can be learned about the behavior of such a system by appropriate over-all measurements of neutron distributions in space and energy, for example. Experiments of this nature are carried out by a group in the Weapons Division. The work is done in a laboratory in which such assemblies involving fissionable material can be made entirely by remote control and the critical condition approached with safety. The results obtained from the experiments of this group provide a valuable confirmation of fundamental data and theory and give information on complicated arrangements which may be extremely difficult to calculate.

A SKETCH of the method by which a new scheme for a nuclear explosive arrangement is developed will indicate the role of the other groups in the Weapons Division. A small group of senior scientists of the Laboratory has the responsibility of originating and exploring various schemes. Initially, the exploration involves largely paper work and the services of the Theoretical Division, but questions requiring experimental answers soon arise, and nearly every division of the Laboratory becomes involved in the task of determining feasibility in principle. Once this is established and it has been determined that a particular scheme merits much more extensive and intensive investigation—perhaps even a full-scale test—the responsibility shifts to the Weapons Division to see that the scheme is engineered, not to the stage of an actual weapon, but to that of a workable nuclear explosive system. This phase may also involve nearly all of the Laboratory and places a heavy responsibility on the groups of the Weapons Division for coordination of effort. Should the results of this effort continue to be attractive, there will be one further shift of responsibility, this time to a Test Division which will carry out the detonation of the device and make appropriate measurements of its behavior. This flow of a laboratory objective involves a maximum participation of the whole Laboratory, yet at each stage there is a clear definition of primary responsibility.

The production processes of Oak Ridge and of Hanford were originally set up before the specification as to size, shape, and purity of active material for explosive purposes was known; therefore, during the war years, the task of establishing purification and fabrication procedures was given to Los Alamos. This work continues to be the responsibility of the Chemistry and Metal-

[2] A "(gamma, n) reaction" is a process in which a gamma-ray is absorbed by a nucleus and a neutron is subsequently emitted; similarly, in an "(n, 2n) reaction," a nucleus absorbs *one* neutron and then emits *two* neutrons.

[3] Neutrons which are captured "parasitically" have no "neutron progeny," and hence are effectively lost as far as the chain reaction is concerned.

[4] If a thin target is placed in a beam of neutrons or other particles, the fraction of the bombarding particles which will undergo some process is given by the product (target thickness) x (number of target atoms per unit volume) x ("reaction cross section" for that process); hence, other things being equal, the rate of a given process is greater, the greater its "cross section."

lurgy Division. The Smyth report has emphasized extreme purity (of the order of a few parts per million) of materials which are to be used in reactor construction. Similar purity is required for materials used throughout the weapon and dictates continued research and development toward better processes for purification, analysis, and fabrication of both active and inactive materials.

As new materials become more abundant the range of possible physical and chemical measurements of their properties and of their compounds and alloys increases; consequently the activity of the CMR Division is not limited to process improvement in the narrow sense, but includes a wide range of fundamental research. As an example of this range, it may be mentioned that the Division operates a cryogenic laboratory which has proved useful not only in extending the temperature range of measurements on ordinary materials but also in investigating fundamental properties of new materials[5] such as liquid He^3.

THE third area of concern to the laboratory—that pertaining to the method of assembly of material in order to produce a nuclear explosion—is primarily the responsibility of still another division of the Laboratory. Although a considerable portion of the research and many of the techniques of this division are of interest, it is not possible to describe them. It will be evident, however, that any mechanism which makes a mass of active material supercritical must do so in a time so small that any energy generation as a result of the supercritical condition does not produce effects which destroy this condition before the energy release attains a significant value. One therefore becomes involved in meeting the challenge of experiments which will reveal the behavior of a system in the short time available, and, in the interests of the residents of New Mexico, without going to actual highly critical assemblies.

Reference has already been made to the tests which are the responsibility of the Test Division and to the scale of temperatures and pressures attained in a nuclear explosion. Not only are these quantities abnormally high, but so are the numbers of gamma rays and neutrons produced. A nuclear explosion, therefore, presents an opportunity to study fundamental phenomena associated with this extension of the range of physical magnitudes as well as a chance to observe integral effects predicted from a long series of calculations incorporating the results of laboratory experiments. Even though the duration of the experiments associated with a test is very short, and the number of repetitions most definitely limited, techniques of observation have been developed. As a result, a test and the activities of the Test Division include extensive laboratory preparation followed by an intricate set-up of field stations for observation of light, blast, and nuclear radiations accompanying a nuclear explosion.

In addition, there are numerous post-detonation results to be obtained, especially the radiochemical analysis of samples of matter. The role of radiochemical analysis is sufficiently important that one finds most of the research in this field concentrated in this Division although the program is by no means limited to phenomena associated with the test. As is well known, radiochemistry supplies powerful methods for the solution of problems of physics and chemistry. Liberal use is made of the reactors and accelerators of the Physics Division in this connection.

It is quite possible that numerous writers have overemphasized the radioactive hazards associated with atomic energy development, nevertheless, these hazards and those from the use of certain toxic materials which the physicist or chemist invariably wishes to handle exist at Los Alamos. The safety of the staff with respect to these hazards is the responsibility of the Health Division. This responsibility involves three areas: adequate control of hazards themselves, detection of incipient overexposure, and therapeutic procedure for the alleviation of effects caused by accidental exposure. In each area, not only certain routine operations are required, but also an active program of research; in the first, research leading toward appropriate instruments and methods of detection of hazards; in the second and third, research toward an increasing understanding of biological processes. The research program of this Division is greatly assisted by the availability of radioisotopes, especially those which can be used to trace out various biological functions. At the present time there is an active program of synthesizing organic compounds which incorporate tracer elements for this type of study.

The technical functions of all of the divisions of the Laboratory as described above are carried out by approximately five hundred technical personnel including nearly a hundred holding Ph.D. degrees in biochemistry, biophysics, chemistry, mathematics, and physics. They are directly assisted by numerous technicians, and indirectly by the Laboratory Administration which provides shop, library, and document facilities, formulates personnel and operational policies, and the like.

[5] Natural helium contains only one atom of He^3, the light isotope, for every million or so atoms of He^4, but it is possible to obtain nearly pure He^3 in usable quantities from the radio-active decay of H^3 (tritium), the latter being produced in piles.

LABORATORY POLICY

SINCE professional interest is not limited solely to the physical nature of a Laboratory and its program but extends into questions of policy, a few general remarks on this subject may be of interest.

The University of California, as operating contractor, and the management of the Laboratory recognize that satisfactory organization involves not only adequate facilities and supporting services but also an appropriate atmosphere. Believing that the research achievements of American universities are due largely to their liberal policies, they have instituted similiar policies at Los Alamos. Seminars, colloquia, courses of instruction, and free discussion throughout the Laboratory are evidence of this policy.

It is recognized that the geographical location of Los Alamos is unusual and could result in a scientific isolation which might easily be detrimental to the work done at the Laboratory. Both the in and out flow of individuals are used to minimize this possible effect of location. Laboratory personnel are encouraged to attend scientific meetings held by the regular scientific and engineering societies and those held by the AEC for its many contractors. Laboratory business, being rather widespread, also provides opportunities for consultation with scientific colleagues in industrial, academic, and governmental environments. It is also possible for a staff member to arrange for a leave of absence to pursue scientific or professional work at other locations. The recognized need for outside talent results in visits to the Laboratory of a rather impressive list of consultants who bring not only information on their special interest but also knowledge of interest to the scientific world at large.

Publication of papers also contributes to a sense of involvement with the scientific community at large, and such publications are encouraged whenever the subject matter is declassifiable. Lest

(Continued on Page 105)

SECRETARY FORRESTAL'S STATEMENT ON BIOLOGICAL WARFARE

The following statement on the potentialities of biological warfare was issued by Secretary of Defense James Forrestal on March 12. This is the first official comment on this subject since the Merck Report, published in the **Bulletin**, October 11, 1946.

WAR inevitably brings with it the development of new and more effective weapons for the destruction of life or property. Such a new weapon was being developed by our enemies during World War II. This weapon was disease—the production of germs for deliberate introduction into enemy territory to cause sickness or death among its people and livestock or the destruction of its food crops. Because of its nature the use of this weapon has been called "Biological Warfare."

It is the responsibility of the Armed Forces of a democratic nation to inform the public of their activities as far as it is consistent with national security. With this responsibility in view, the War Department on 3 January, 1946, released a report by Mr. George W. Merck to the Secretary of War. This release informed the public of the combined efforts of American scientists and industry working with the Armed Forces, and in cooperation with agencies of our allies, to develop means for defense against possible enemy attacks by biological warfare.

Obviously in the press release concerning the Merck Report (which subsequently was withdrawn from circulation), it was not in the national interest to reveal in any detail the extent of progress made in this new field of military research, or to attempt a definite evaluation of the capabilities and limitations of this new weapon. The announcement was followed by a number of unofficial articles in newspapers and magazines and the subject was also discussed in domestic and foreign radio broadcasts.

Owing in some measure to the limitations of official information, a great deal of this discussion was extravagant, inaccurate, and unduly spectacular in the light of present scientific knowledge. Some was so sensational as to be completely misleading. Such treatment unfortunately overshadowed in the public mind those articles which presented more sober and reasonable reflections on the subject. Therefore it is felt advisable that the American people be given an official statement concerning the potentialities of biological warfare.

Prompted by intelligence reports of enemy activities in this field during World War II, intensive investigations of the possibilities and potentialities of biological warfare were initiated in the United States in close collaboration with our British and Canadian allies. These investigations were aimed primarily toward securing for this nation adequate protection against the possible use of biological warfare by our enemies. Towards this end army, navy, and civilian scientists, universities, private research institutions, industries, and several departments of the Government all worked together.

THE Chemical Warfare Service, now the Chemical Corps, was made responsible for the program in the War Department, with the cooperation of the Office of the Surgeon General on certain medical aspects. The Navy Department worked in close collaboration with the War Department in this field and made important contributions to the program. Since these investigations involved many sciences and entirely new approaches, unique facilities had to be constructed to enable us properly to conduct our research.

Actually large-scale biological warfare has never been used by any nation. Our research indicated, however, that germs or their poisonous products could be used effectively as weapons of war. It was also realized from the results of this wartime research that work in this field could not be neglected in time of peace and had to be continued on a sufficient scale to provide us with adequate defenses and to enable us to utilize this weapon in the future should it become necessary.

As a by-product of the research on this subject during and following the war, much information of great peacetime benefit to mankind in the medical, agricultural, and allied fields has been freely given to the public. Over 160 technical articles describing these investigations have been released through the medium of scientific journals.

Unfortunately, the public has been given an exaggerated impression as to the potency and state of development of biological warfare. For example, it has been stated that a single plane with a small bomb filled with a biological agent would be capable of wiping out the population of an entire city with a single blow. Such a statement is not in accord with the facts as we know them today.

As a further example, in a recent article it was stated that one ounce of a particular biological material would be sufficient to kill 200,000,000 people. The facts are that it is impossible to spread an ounce of any kind of material for the purpose of warfare in such a manner as to affect even a small percentage of such a tremendous number of persons.

Many other exaggerated statements have appeared. One article stated that biological warfare makes it possible to kill the inhabitants of an *entire continent* very quickly. Another stated that it would be a *simple matter* to spread plague in the United States. Still another maintained that a means is available for spreading various diseases among *millions of people* by dropping a *few capsules* from *one airplane*. Such claims are fantastic and have no basis in fact.

WHILE it would be folly to underestimate the potentialities of biological warfare, there is no factual basis for *extravagant* claims of the existence of a biological super-weapon.

Many articles have described biological warfare as more terrible than the atomic bomb. The fact is that these two weapons differ from one another so basically that a direct comparison is meaningless. The atomic bomb destroys not only life but also buildings and other structures, and is in that respect similar to high explosives. In addition, atomic radiation may persist indefinitely in contaminated areas and produce serious effects on living matter.

Biological warfare agents, on the other hand, affect only living matter, do not destroy material structures, and, in most cases, are nonpersistent. Death, protracted sickness, or only temporary incapacitation might be produced in man by the selection and dissemination of the proper biological agent.

Biological warfare is an attempt to harness certain forces of nature for purposes of war. In such warfare either epidemic or non-epidemic diseases might be used. In the language of biological warfare, an epidemic disease is one that is easily and rapidly spread from person to person, animal to animal, or plant to plant. A non-epidemic disease spreads less easily and, therefore, would be largely restricted to persons, animals, or plants directly exposed to the germs as they were distributed during an attack.

In the case of epidemic diseases of man the factors governing spread are not completely understood, and in any case not all are controllable; hence, it is not at all certain that an epidemic of significant proportions could be produced at will.

Even if an epidemic were started, adequate public health and sanitation measures and proper treatment methods promptly instituted would tend to limit the spread and minimize the effects. The distribution of non-epidemic disease-producing agents and toxins would have to be very widespread to have a decisive effect. Biological warfare would not be instantly destructive of life and it should be appreciated that illness induced by biological agents may be counteracted by specific medical measures.

An important defense against biological warfare lies in the early identification of diseases implanted and prompt institution of appropriate countermeasures to prevent further spread and restore the health of those affected. But it is obvious that extensive preparation for such defensive measures must be made in advance of an attack.

During times of peace various governmental agencies are concerned with the control of natural outbreaks of disease. Not only our population but also our crops and animals must be protected. To this end the U. S. Public Health Service, the Department of Agriculture, other federal and many state and municipal agencies are always on the alert. The threat of biological warfare has increased their responsibilities and difficulties. If a biological attack were made, the above agencies, in addition to the Armed Forces, would play an important role in counteracting the implantation and spread of disease.

We must guard not only against natural outbreaks of disease and biological attack in time of war, but also against the use of biological sabotage methods before a declaration of war has been made. Our food supplies would be particularly vulnerable to attack by saboteurs with biological weapons.

We must, therefore, rely on the maintenance of our high standards of public health and sanitation, and on our protective measures for animals and crops as our first line of defense against any biological warfare attack.

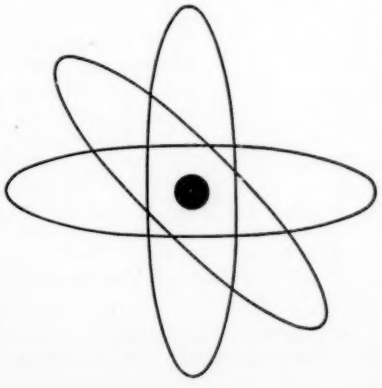
Appropriate steps are being taken to insure the coordination of the activities of our protective agencies. In addition, an active research program on biological warfare including methods for the prevention and treatment of diseases which might be caused by such warfare is being conducted in the interests of national defense.

Los Alamos Laboratory

(Continued from Page 103)

one suppose that because of the nature of the work very few papers appear from Los Alamos, it may be mentioned that to date two hundred papers have been declassified for publication. The reason, of course, is not particularly profound but is coupled with the recognition that basic fundamental research is essential to the health of the Laboratory. This recognition, plus the wise policy of the AEC in encouraging, wherever possible, the dissemination of fundamental scientific information results in the production of papers of this type and their subsequent release.

Although there is not the same demand or opportunity at Los Alamos for arrangements similar to those at the national laboratories of Argonne, Brookhaven, and Oak Ridge, nevertheless, a certain type of cooperation—perhaps more individual than institutional—takes place. In addition to the consultants who visit Los Alamos for periods of a few days to several months, the Laboratory employs some twenty to forty predoctoral students for the summer period. In this way the student acquires a familiarity with the Laboratory, the Laboratory's personnel with him, and he has an opportunity to gain research experience through his assignment to a research group in his field. These employees are taken on a merit basis, and applications must be received by the Laboratory before February 15th of each year.



Even though no formal, regular arrangement exists with any specific institutions, consideration is given to the employment of individuals recommended by various colleges and universities for doctoral thesis work at Los Alamos. This policy benefits the institution which may not possess the required facilities, and Los Alamos, which gains the student's contribution to the work of the Laboratory, and his possible interest in continuing postdoctoral employment.

Another factor contributing to the professional health of the Laboratory is a continuation of the sound wartime policy of no compartmentalization within the technical sections of the organization. In the new and strange field in which this Laboratory operates, ideas of value may not necessarily always come from the individual who is supposed to have them, and a free flow of problems and information among the senior scientists is important in maintaining progress.

Los Alamos is cognizant of its role in our national policy—that of maintaining our pre-eminence in the field of atomic energy. It is also aware that although it is primarily concerned with the military applications of atomic energy, nevertheless, for the same reason that this nation has insisted on adequate international control, namely, the lack of a clean division between peaceful and military applications of atomic energy, its efforts and accomplishments will have other applications than purely military ones. These broader objectives and the primary aim of maintaining our lead in atomic energy development therefore form the basis of the efforts of the Laboratory along the functional lines outlined above, and stimulate the staff in its desire to maintain and improve a laboratory of recognized scientific tradition and accomplishment.

FREEDOM OF SCIENCE

The following views on freedom of science were expressed by Professor Peierls and Sir Henry Dale at a conference of the British Atomic Scientists' Association held in London last October. R. E. Peierls is Professor of Mathematical Physics at the University of Birmingham. Sir Henry Dale is a former president of the Royal Society and winner of the Nobel Prize for Medicine. The first session of the conference was reported in the February issue of the **Bulletin.**

PROFESSOR PEIERLS began by discussing the change that had taken place in the position of scientists, particularly of atomic scientists, since the liberation of atomic energy. They now find themselves in a dual position. "On the one hand we are, many of us, in the confidence of the government which has entrusted us with information which is, or may be, of military value. At the same time, those of us who work in universities or other academic research institutions are members of a community in which we have pledged ourselves that the results of our work must be made freely available, in the first place, to the community of scientists as a whole, and, secondly, to the general public if they are of sufficient interest."

Professor Peierls went on to say that these two conflicting roles could be reconciled because the information involved fell into two distinct classes. Those questions which are of interest to the government usually deal with the development of practical applications and normally are not problems of fundamental interest which would attract scientists for their own intrinsic value.

"Very fortunately, no attempt has been made to control the publication or discussion of these more fundamental problems. This might not have been so, since it can be argued that the fundamental problems of today are the basis of the practical applications of tomorrow and that all should be controlled. Such interference would have been disastrous for all forms of scientific research. It would have made it very difficult for scientists to cooperate with the government, and the proscription of open discussion would have greatly hampered the progress of basic research."

Professor Peierls continued: "In the same sense, we have always regarded it as important for the general development of science that there should be the freest possible exchange of information between scientists of this country and those of any other country where there are scientists who want to know what we are doing and who are prepared to tell us what they are doing.

"In a recent memorandum published by the Association, we made just this statement that we believed these contacts between scientists were still useful. We meant they were useful, not merely for the development of science, but also more generally because of the personal contact between individuals, who find it easier to get along with people from different countries, since science is in its nature international, and once you talk to people on your own subject, it is easier to talk to them on general problems. We almost left out this remark, not because we did not believe it, but because we thought it so obvious and it had been said so often that there was no point in saying it again. To our great surprise, just this part of our statement was severely criticized from many quarters.

"The criticism was roughly based on this—that we should not try to maintain our contact or even improve our contact with scientists in countries behind the so-called 'Iron Curtain' because in those countries academic freedom no longer exists in the form in which it is known here, and while we might be able to tell scientists in the Eastern countries what we are doing, we would not get in return what they are doing. There would be, it has been stated in several articles, a one-way traffic of information which would act to the disadvantage of the Western countries in general.

"This is, in my view, based on a complete misunderstanding of how science works. First of all, as regards secrecy, the legal position in this country and in the countries of Eastern Europe is not really very different. It has been said that the scientists in those countries are servants of the State, but so are we, at least in our capacity as consultants to the government. The government in Russia or in any country can presumably forbid a scientist to discuss certain things. Our government can here, when these things are connected with atomic energy.

"More than that, it has been said that the scientist in Russia is only free to discuss and publish what has been specifically permitted. That may be true. The Atomic Energy Act prohibits discussion in a very wide field which certainly contains most of nuclear physics, except for those parts exempted by an order made by the Minister. He has made such an order, and this puts the position right for practical purposes because it exempts from this ban everything which any academic scientist would want to talk about in practice. It is important to remember, however, that we have this freedom, not as a matter of legal right, but by permission which can always be withdrawn by executive action."

PROFESSOR Peierls stated that contact was still possible with the physicists of the satellite countries (Poland, Hungary, etc.), and that, as far as could be judged, they are still as free as we are to publish the results of their work even if they have lost their freedom in other respects and are subject to dismissal for what we should consider to be inadequate causes. "There seems to be no reason why we should not talk to them as one member of a scientific community to another.

"As regards Russia proper, the situation is more obscure since, through no fault of our own, we have been unable to maintain contact with her physicists. They have not accepted invitations to our conferences, and Russian scientific periodicals in foreign languages have been discontinued. This last is probably connected with motives of national pride rather than anything else. Russian language periodicals continue to arrive in this country as well as they ever did; that is, rather erratically."

The speaker went on to make the further point that one very often gains

considerably by being able to discuss a problem with a colleague, even if he volunteers no information, merely by the clarification of one's own outlook which occurs. However, it is essential that the scientists whom we meet should be free to advocate what they believe to be true and should not be confined by some official orthodoxy. "We would find it impossible to derive any benefit from discussion with people who blindly accept the officially sponsored views. If we were able to get together with scientists whose views were not influenced by some official action or prejudice we should welcome them at any time, regardless of whether or not their views coincided with our own."

HE WENT on to condemn interference with the position of individual scientists by governments on political grounds and deprecated the action of those scientists who too easily accept government interference in their institutions. Of these, he said, "It might certainly rob them of our personal respect, but I believe it is no reason why we should refuse to accept their scientific views or scientific work, or that we should refuse to give them all the information in our possession and all help in obtaining information, except where we are bound by regulations.

"Certainly, in the years before the war, we have had discussions with German scientists of whose personal integrity we had the greatest doubt. Nevertheless, we have used their work and learned from their professional views as long as they kept these free from other matters. We refuse to have anything to do with some people personally. That is our private affair and not a professional one."

Professor Peierls continued: "One hears a good deal of talk about the dangerous effects of scientists who hold subversive views of one kind and another, and this, fortunately, is not taken very seriously in this country. I believe most of you know that in the United States things are rather more difficult in that respect.

"I think we must distinguish carefully between scientists in general and those in a position of confidence who are entrusted with information of potential military value. It has always been the practice of the military authorities to look carefully at those whom they take into their confidence, and it must be left to them to do their job in the best possible way. The only thing we must ask is that, when they do not give the person concerned the benefit of the doubt (we must admit that in some cases they would rather, in a case of doubt, take the safer course and not employ the person whom they doubt on a job involving security) we must insist that in such a case no harm should arise to the interests of this person, and, in particular, that there should be no difficulty in his getting work of other kinds.

"There is a growing tendency to regard all people of undesirable views with suspicion, even in positions where there is no question of military secrets. I think we should try to distinguish between political views and professional views. If we believe anybody in any position uses or misuses his position and is influenced by his political views in his professional judgment, that is a different matter. He ought then to be attacked on the method by which he carries out his job and not on the political views he holds. I think it is essential that we should not overrate this danger, but we should be on the look-out. I believe this applies not only to science but to many other spheres in which political questions should not be involved. We ought not to be prejudiced against people on account of their political views.

"It is very important that we should not limit the freedom of the individual to form his own political views and we should not be misled by the dangers of possible war into taking steps which will, in fact, weaken us. In the present international situation, and certainly in the event of a war in the near future, in which I personally do not believe, it lays us open to the suspicion that we state our principles only when it happens to be convenient, and do not apply them seriously in our daily lives. This is my last point. I am afraid I have gone beyond the field of the scientist as such, but these are matters upon which I feel very strongly."

SIR HENRY DALE dealt with the same general theme, namely, that of secrecy in science. He said: "It is a subject on which I feel rather deeply. I fear that it is becoming almost too difficult for some of us even to imagine the freedom of cooperation and the community of interest among all men of science throughout Europe, and indeed throughout all parts of the world as science became active in them, which existed for centuries right up to a time within the memories of colleagues of ours who are still alive. The world-wide scientific community of those days took no account of frontiers, of national policy or political sentiment, even during a war.

"Probably most of you have heard that Humphrey Davy, early in the nineteenth century, was actually feted in Paris by his colleagues of the French Academy of Sciences, when this country was still at war with France. To take a parallel example, imagine what we should have thought if one of his scientific descendants had visited Germany in the early days of the last war and had been feted in Hitler's Berlin!

"Even the breach made between French and Germans by the Franco-Prussian war, the first to be fought on a truly national scale, left a division of political and personal sentiment, but very little division of scientific activities. The French were for some years unwilling to visit Germany, or to receive German scientists on an official basis, but I am sure there was plenty of individual interchange and no question of scientific exclusiveness.

AS LATE as 1907, I was present at an International Congress of Physiology at Heidelberg, which, because of the survival of the resentment from 1870, was the first such congress to be held in either Germany or France. I remember well the general air of relief and rejoicing and the enthusiasm which greeted Charles Richet's declaration that Science should know nothing of political frontiers and national jealousies.

"Right up to 1914, that seemed to be the position. There were, indeed, a few of our colleagues whose activities were hidden and segregated for work on the chemistry of explosives and the mechanics of torpedoes and things of that kind, but we met them on a personal rather than on a scientific basis. There was another, but still relatively small, contingent, some of whose work was subject to a temporary kind of secrecy for commercial reasons. But scientists in general enjoyed the greatest freedom of publication and of direct communication with one another, and with foreigners as freely as with their own countrymen.

"The curtain came down, of course, with the World War of 1914, but after 1918 we soon began to get it up again, though never quite to its former full extent. A larger part of the general stream of science than ever before remained diverted into secret channels. That was, I think, to be expected. Recognition had dawned of a possibly decisive contribution to military preparation by science. Nevertheless, the general impetus to and support of scientific activity was so much greater that the main

current remained free and in bigger volume than before. It was still possible to maintain that, with the exception of certain rather closely defined applications, science was again the most completely international of all man's major intellectual activities.

"I mention these past conditions and the beginning of the decline from them, which we may hope is only temporary, not merely, of course, as the appropriate object of a resigned and helpless nostalgia, but rather as an ideal which we ought on no account to relinquish; we must keep it always before us as something, not immediately practicable indeed, but to be striven for, to be recovered, and to be re-established as soon as possible.

"At present we have been forced very far away from it, and the immediate call for our effort may be to challenge, to examine, and, if need be, to resist any move or threat to push us farther down the slope. I am old-fashioned enough to regard Liberty, which has been badly blown upon from more than one quarter in these recent years, as still the most important object of corporate human action, and we must be determined to keep it for science and for all other serious human activities.

YOUR particular concern is to retain the greatest practical freedom for research and interchange of experience on nuclear physics and atomic energy. I do not need to tell you that this is not my own subject. My official position during the war took me behind the general curtain of secrecy guarding it, not by any means behind the curtain of the innermost secrets, such as Professor Peierls had access to, but sufficient to give me a general knowledge of what was going on before anybody outside knew anything about it. Thus I had the opportunity of seeing the danger which would remain for the freedom of science when war ended.

"The official and military mind had many other opportunities for experience of what secret applications and developments of science could do for effective action in war; but the atomic bomb involved a much more widely embracing secrecy than any of these others. Scientists, on their part, had, I fear, become unduly tolerant of work under such conditions. It was clearly not going to be easy for science to regain its former freedom.

"On the other hand, I think we can agree with Professor Peierls, that things might have been very much worse than they actually are. There is still a great deal of secrecy about large areas of work on atomic energy but, as he said, there has been relatively little, if any, encroachment on the field of fundamental nuclear physics. I think that has been largely due to a healthy defensive uprising of scientists, and I think we should here pay a special tribute to the staunchness in that respect of a large majority of our American colleagues who were involved in this work.

"With world affairs as they are, it is useless now to hanker after such ideals of freedom as would be obtainable only if the international situation were very different from what it is. We are not going to be such fools as to demand removal of all restraints on our freedom of action from one direction, at the risk of its complete, and perhaps final, extinction from another. We have to be alert and watchful against any threat of encroachment on it from whatever quarter it may come."

SIR HENRY went on to emphasize that so long as secrecy was required for some parts of scientific knowledge, it was absolutely essential that the line of demarcation between the secret and the free should be drawn clearly and unambiguously. He agreed entirely with Professor Peierls that it was nonsense to suggest that we should refrain from all contacts with scientists on the other side of the Iron Curtain.

"One does not need to be particularly cynical or suspicious, surely, to hold that if a matter has to be kept secret from scientists of any nationality, it must be secret from those of all others, including our own, and must be mentioned only to the few who legitimately share knowledge of it already. On the other hand, if it has been decided that it is a matter which has no danger from the point of view of secrecy, it is absurd to suppose that we should be allowed to discuss it with scientists from the Benelux countries, Italy, or Greece and, that, at the same time, there should be an understanding that there should be no direct discussion on it with scientists from behind the Iron Curtain. That is not practical politics. That is not common sense."

Sir Henry denounced in very strong terms the coercion of geneticists in Russia. "Unless a geneticist will profess and proclaim belief in what he, with every responsible geneticist in the world, knows to be nonsense, he is dismissed and liquidated. There has been nothing like it since an earlier orthodoxy sent Giordano Bruno to the stake and the cardinals bullied Galileo into disclaiming what he knew to be scientific truth."

The speaker added that although he was in favor of the widest possible cooperation between scientists of all countries, we must be careful that, in attempting to attain this end, we do not inadvertently give countenance to such a state-controlled form of pseudo-science and thereby discourage our suffering colleagues in these countries.

"I am all for maintaining a cooperative interchange of experience with our fellow-scientists behind the Iron Curtain. Let us have them visit us and visit them when we can, and let us make the area as wide as possible, provided that we visit and invite the right people and not merely the political time-servers. Science, first in Hitler's Germany and now in Stalin's Russia, has been subjected to political domination. Surely that is a warning to us to keep a watch on politicians of all colors and parties, and to be ready to stand like a rock at the first sign of an attempt to make truth subservient to any political ideology or expediency. It will be of no use for us to keep science free from excess of military secrecy, if we let it fall into servitude to a political tyranny."

DR. BURHOP asked Sir Henry Dale for the evidence on which he based his statements that geneticists in Russia were being dismissed, *and liquidated*, saying that this was a very serious charge. His main purpose in speaking was to discuss what is happening to scientists in America and, on a much smaller scale, here: that is, the dismissal of government scientists because of their alleged political views.

"In America, this persecution has assumed extreme forms through the activities of the notorious Thomas Committee on Un-American Activities. Some of us have followed with interest the active fight of Dr. Condon in this matter. I think most of us congratulate him on having come out of the fight with his colors flying. I read the clearance order and I could not feel anything but uneasy about what could happen when it seemed accepted as a natural thing for some three hundred of his associates and acquaintances to be questioned as to his views. I think if that goes on, it is a bad thing. Of course Dr.

Condon is a well-known scientist. What happens to the lesser known men?"

Sir Henry Dale said: "Perhaps I should not have used the word 'liquidate' with a general application. I agree that it is a serious charge. I had in mind the case of Vavilov. He asks me whether I have any evidence about the fate of Vavilov. I can only ask if he can make any kind of suggestion as to how I can obtain the information. I can assure him from direct personal knowledge that every effort has been made.

"In 1942 I happened to be President of the Royal Society, and the name of Vavilov was brought before the Council of the Society, with the strongest kind of recommendation, from those who knew about his work, for election to the foreign membership. He was elected to foreign membership. We heard faint rumors of his having got into some kind of trouble because he openly opposed the teaching of Lysenko. It came to our knowledge in 1945 that somewhere between 1941 and 1943 Vavilov had been dismissed from his appointment and had been removed from Leningrad to a distant region in Russia where there was known to be a concentration camp, and that somewhere between 1941 and 1943, he died.

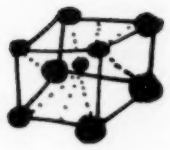
"We naturally wished to know, simply for the completion of our records, what was the date of his death. We wished to know whether or not this great man was ever a foreign member of the Royal Society of London. We have been entirely unable to find out. Every inquiry put through every kind of channel has encountered a complete blank. What was the manner of his death? No acknowledgment of any kind has been sent through the Soviet Embassy in London or from Moscow by the President of the Scientific Academy.

"I ask Dr. Burhop again, can you suggest a method? Nothing would delight me more than to be able to get information which would disclose that Vavilov died a natural death."

Dr. Burhop: "I think you said he had been liquidated."

Sir Henry Dale: "The statement has been openly published by people who have made what inquiries they can in Russia. His death is known to have occurred, but even the date of it cannot be elicited by the most polite and official inquiries. I leave you with the fact. I ask you whether you can make any suggestion by which a more exact truth of the matter can be established. I venture to think that I have the right to assume, in those circumstances, that what is stated by Vavilov's friends is correct."

JOLIOT-CURIE AND THE ATOMIC SECRETS



Professor Joliot-Curie's speech before the Anglo-American Press Association on January 5 has provoked much discussion in the press. Together with the commentary here reprinted from the British **Economist**, it shows that the problem of isolating Western atomic energy developments from those in the Soviet-dominated East, is more complex and difficult than may appear from this side of the ocean.

The Anglo-Saxon policy of maintaining secrecy in certain fields of nuclear science may become illusory and need revision if France upholds the pre-war policy of free publication. This is quite apart from any "leaks" of industrial and military secrets which may develop through Communist associations on the part of many French scientists.

Joliot-Curie's statements illuminate the fact that the incompatibility between patriotism and Communism with its allegiance to the Soviet Union appears much less obvious to many European intellectuals than it does to the majority of their American colleagues.

THE completion of the first French nuclear reactor (low-energy, uranium-oxide, heavy-water-moderated pile, surnamed ZOE) has attracted general attention as the first such development outside the U.S.-Canada-Great Britain bloc. American and British commentators have suggested that, as loyal Communists, Professor Joliot-Curie, head of the French atomic energy project, and many of his co-workers, will be under obligation to put all their findings at the disposal of the Soviet Union, and will thus be helping the Soviet development of atomic bombs.

Here is what Joliot-Curie said in his prepared speech:

"In accordance with the instructions of our government, our researches and achievements are exclusively directed toward peaceful ends. Thus, the first pile will permit us to prepare radioisotopes (discovered in France in 1934) which are so valuable for research in biology, medicine, etc. It will also allow us to increase our knowledge of nuclear physics and to train numerous technicians necessary for our progress in this field.

"This achievement—which is only a part of what we have already accomplished—is the work of all those employed in the Commission—workers, engineers, scientists, administrators. All these men and all these women, of very diverse political and religious opinions, form a team, united because they have a common purpose: to give atomic energy to France. They work with confidence because they know they are supported by the French people who wish to assure the maximum independence to their country.

"From now on we will continue our work with a view to constructing a second, and more powerful, pile. There is reason to believe that we will successfully surmount the difficulties in this second stage, provided our country continues to have confidence in us.

"Our accomplishments in the field of atomic energy are entirely French, and their development, and the choice of the men responsible for them seem to me to concern only the French people.

"Undoubtedly, this is not the view held by those who have prompted certain articles in the Anglo-American press, among which I would mention one in the *Observer* of December 19, and another in the *Economist* of December 25, which, in turn, refers to an article in the *New York Herald Tribune*—all of them authoritative journals.

"If one wanted evidence of Anglo-American meddling in the domestic affairs of France, one couldn't do better than this. Articles like these contribute strongly to the clarification of the issues in the minds of Frenchmen, the vast majority of whom are strongly attached to their national independence. Any infringement of this, regardless of its source, is keenly resented.

"These articles have been provoked by the anxiety shown in the United

States and Great Britain at the spectacle of French progress in the field of atomic energy—an enterprise in which important posts are held by Communists, and of which the High Commissioner is a member of the Communist Party.

"Thus, the *Economist* says:

" 'Russia, which is in process of obtaining the secrets by her own efforts, will be able to profit greatly from the results obtained in France, through the channel of the Communist Party.'

"It is to this particularly slanderous and offensive accusation that I wish to reply. First, the results of our theoretical research in this field will continue to be published, and thus the whole world, including the USSR, will be able to profit by them.

"As to the practical applications, it seems necessary to me that those developments which have been obtained with peaceful ends in mind, but could lend themselves to deadly use, should be kept secret so long as weapons of mass destruction, like the atomic bomb, are not outlawed by the United Nations.

A FRENCH Communist, like any other French citizen holding a post entrusted to him by his government, could not possibly think of communicating to any foreign power whatsoever, results which do not belong to him, but to the community which has permitted him to work. Any Communist is perfectly aware of the necessity for this conduct.

"To put the matter bluntly: tomorrow, I, or one of my colleagues, make a discovery vital to the production of atomic weapons. The authors of the articles cited above suppose that our duty, which we willingly subscribe to, would be to communicate all the details of such a discovery to the Moscow government. Apparently we intend to commit the crime of treason, and it would be fitting to punish us in advance.

"What facts support such an accusation? Or, in the absence of facts, what suppositions underlie this absurd argument which leads to the conclusion that to be a Communist is to be relieved from the moral obligations of a French citizen and to be automatically transformed into a spy, well-meaning or otherwise?

"The security measures which are recommended for France are already in force in the United States. One has only to read the scientific journals of the United States in order to see the profound *malaise* caused by the activity of the Thomas Committee. I have read with amazement in the *Bulletin of the Atomic Scientists* the ridiculous charges brought against many of my American colleagues, whose patriotism is above suspicion, like Mr. Condon, of the Bureau of Standards, for example. This atmosphere of suspicion ill serves the country it pervades, and many eminent American scholars have already protested. Certain of them have even voluntarily resigned from their posts in order to seek employment where 'security' is not a factor. Is it by provoking this kind of reaction that one really makes a country more secure?

"Certainly, the Communists, and not only the Communists, feel great admiration for the work of the Soviet Union, just as in 1792 many citizens turned with hope toward Revolutionary France. The republicans who, in their respective countries, fought social injustice and the monarchy—were they not traitors, French agents? Yet they were true and honest patriots!

"Like the republicans of that period, with all the progressive elements, we in our country wish to fight, within the framework of our democratic constitution, to establish social justice and greater prosperity—conditions which we consider favorable to the peaceful organization of a socialist world.

"Our actions do not, as is falsely claimed, tend to weaken our country in order to facilitate foreign domination, but, on the contrary, they tend to enrich it intellectually and economically. Thus, France, for the gain of all nations, will be able to preserve her creative gifts and her fine traditions."

ACCORDING to reports in the American press, Professor Joliot-Curie made additional remarks in answer to queries by the correspondents present at his speech, in which he re-asserted his deep belief in the Communist cause, and recommended to France the role of a mediator between the Communist system of the Soviet Union and the capitalist system of America.

The tone of Professor Joliot-Curie's statement, with its emphasis on national loyalty and inclusion of the Soviet Union among the foreign countries to which no atomic secrets of military value should be revealed, was so different from the tone of many pronouncements of the most prominent Communist leaders in France and elsewhere, that immediately after his January 5 speech, rumors arose that he had been censured or even expelled from the Communist Party. An article in the Independent newspaper, *France-Soir* said on January 15 that Joliot-Curie had been "disavowed" by the Communist Party and charged with "Titoism."

However, the official party organ, *Humanité*, expressed its displeasure, if any, only by making no reference at all to the speech. On January 17, Joliot-Curie denied that his speech had caused any disagreement between himself and the party and emphatically re-affirmed his statement of January 5.

Taking his statements as an honest expression of his present beliefs as a Frenchman and a Communist—and many of his scientific colleagues will be unable to consider them differently—they still leave open a number of questions of considerable importance from the American and British point of view. We can illustrate these by quoting from an article in the British journal the *Economist*, of January 15:

THE possession by the French Government of an operating chain-reacting nuclear pile marks a significant change in the status of atomic energy as a factor in current political affairs. Until December 15, 1948, the only nuclear piles known to be in operation were in the United States, Great Britain, and Canada. Of these, three were in British countries and another dozen or so in the United States. Some of them are being used for the production of plutonium, others for research on atomic weapons, and still others on problems connected with the peacetime applications of atomic energy.

"In spite of their different purposes, all the Anglo-Saxon piles have one element in common: they are operated by governments which have set strict limits on the publication of information connected with pile construction, or information derived from pile operation. Staff are chosen with special attention to their political reliability. A form of censorship is carried on by each of the three governments involved, and they consult from time to time so that a common policy may be maintained.

"The French pile is the first to fall outside this three-power association. The French Government has established no formal censorship over atomic energy research as such. It has never established political requirements for scientists working on applied nuclear physics. There are no limitations on the publication of results. It is a party to no formal agreement which would oblige it to consult with other nations concerning its activities in atomic energy. . . .

"A low-energy chain-reacting pile, such as the one at Chatillon, makes no significant amount of plutonium and is therefore not a production process like the American piles at Hanford, Wash-

(Continued on Page 126)

PLANNING FOR CIVIL DEFENSE

Russell J. Hopley

On November 13, 1948, the Office of Civil Defense Planning, directed by Russell J. Hopley, issued a 300-page report on **Civil Defense for National Security.** The following brief outline of the plan has been condensed from a speech made by Mr. Hopley in Omaha on December 10. President Truman has recently rejected proposals of the Office of Civil Defense Planning for the establishment of a permanent civil defense office, as recommended in the Report, and has placed responsibility in this field on the National Security Resources Board.

ON FEBRUARY 15, 1948, the report of the then War Department Civil Defense Board was released for public information. One of the principal recommendations of this board was that a general civil defense plan should be formulated for the United States and its Territories and possessions.

On February 22, 1948, I was asked by Secretary of Defense Forrestal to organize and direct the fundamental plans and organizational structure for the civil defense of the country.

We had available to us the experience, recommendations, and findings of the United States Strategic Bombing Survey in Europe and Japan, and the World War II experience of the civil defense organizations in Europe, Japan, England, and our own country.

It may surprise some to learn that Japan had the oldest civil defense system, first organized in 1923. Their system was not very effective because the military kept telling the people that an enemy attack could never come to Japan, with the result that the people did not work at it.

Germany had what could have been a strong system, except for the fact that there were too many people reaching out for power and constantly attempting to exert political control over the various segments of the organization. In addition, it was hampered by administrative muddles. The result was constant conflict and a poorly working system.

England had the strongest and most effective civil defense program, organized four years prior to World War II. The people worked at it, and the result was an effective system which contributed greatly to the survival of England and the actual winning of the war.

In our current planning activity, we attempted to escape the pitfalls and errors in all of the previous experiences.

Briefly, our final program, entitled *Civil Defense for National Security*, proposes:

1. The establishment of a permanent Federal Office of Civil Defense within the executive branch of the Government, headed by a strong and able civilian director.

2. Within this office, a technical staff, headed by a deputy director, with divisions comprising: communications, engineering, fire services, police services, warden services, and emergency transportation.

3. A plans and operations staff, headed by a deputy director, with divisions comprising: organization and methods, mobile reserves and mutual aid, evacuation, aircraft observers and air raid warning, manpower and materiel, plant protection, and civilian war aid.

4. A training staff, headed by a deputy director, including: field services, methods and training materials, public education, schools and colleges, and leadership training.

5. A medical and health services and other special weapons defense staff, headed by a deputy director, to include medical and health services, radiological defense, chemical defense, and other special weapons defense.

6. We also propose the establishment of regional coordinators to assist in coordinating the activities of state and federal organizations and these with the military and other agencies, when involved.

7. Our plan contemplates the establishment of a civil defense agency within each state, with the governor as the responsible head, the appointment of an advisory council, composed of representative citizens of the state, to advise on civil defense matters—the state activity to be headed by a director. The various operating divisions in the state organization would be similar to those in the federal organization.

8. Similarly, the establishment of a civil defense agency in each community, with the mayor as the responsible municipal official, with an advisory council of representative citizens, and the local activity to be headed by a director. Here too, the various operating divisions in the local organization would be similar to those in the state and federal organization.

9. Our entire plan is proposed on the basis of:

A. Placing full responsibility for operations on the states and communities, where we think it properly belongs.

B. Using the federal organization to furnish the leadership and guidance in organizing and training the people for civil-defense tasks, coordinating efforts, supplying training materials, and providing the advice and counsel which is needed.

C. Making maximum use of volunteers, existing agencies and organizations—government, public, and private—and all available skills and experiences.

D. Developing well-organized and trained units in communities throughout the country, prepared and equipped to meet the problems of enemy attack and to be ready against any weapon an enemy may use.

E. Intensive planning to meet the particular hazards of atomic or other modern weapons of warfare. (The atomic bomb is a triple-threat combination of (1) a high explosive, (2) a superincendiary, and (3) extreme radioactivity.)

F. Organizing a small nucleus peacetime organization which could be used in the event of peacetime disasters such as fires, floods, explosions, tornadoes, and other similar catastrophes, and that could be quickly expanded to meet the exigencies of a given situation in a war emergency.

The plan and the legislation which we propose have been developed on a model basis for the federal, state, and municipal organization, and can be easily modified and adjusted to meet a particular situation in the community or state.

Our plan and legislation also contemplate that the organization will not engage in any political activity or any other activities outside the purely civil-defense field.

Civil defense, as related to a community, rests on the following bases:

1. The individual, who, with proper

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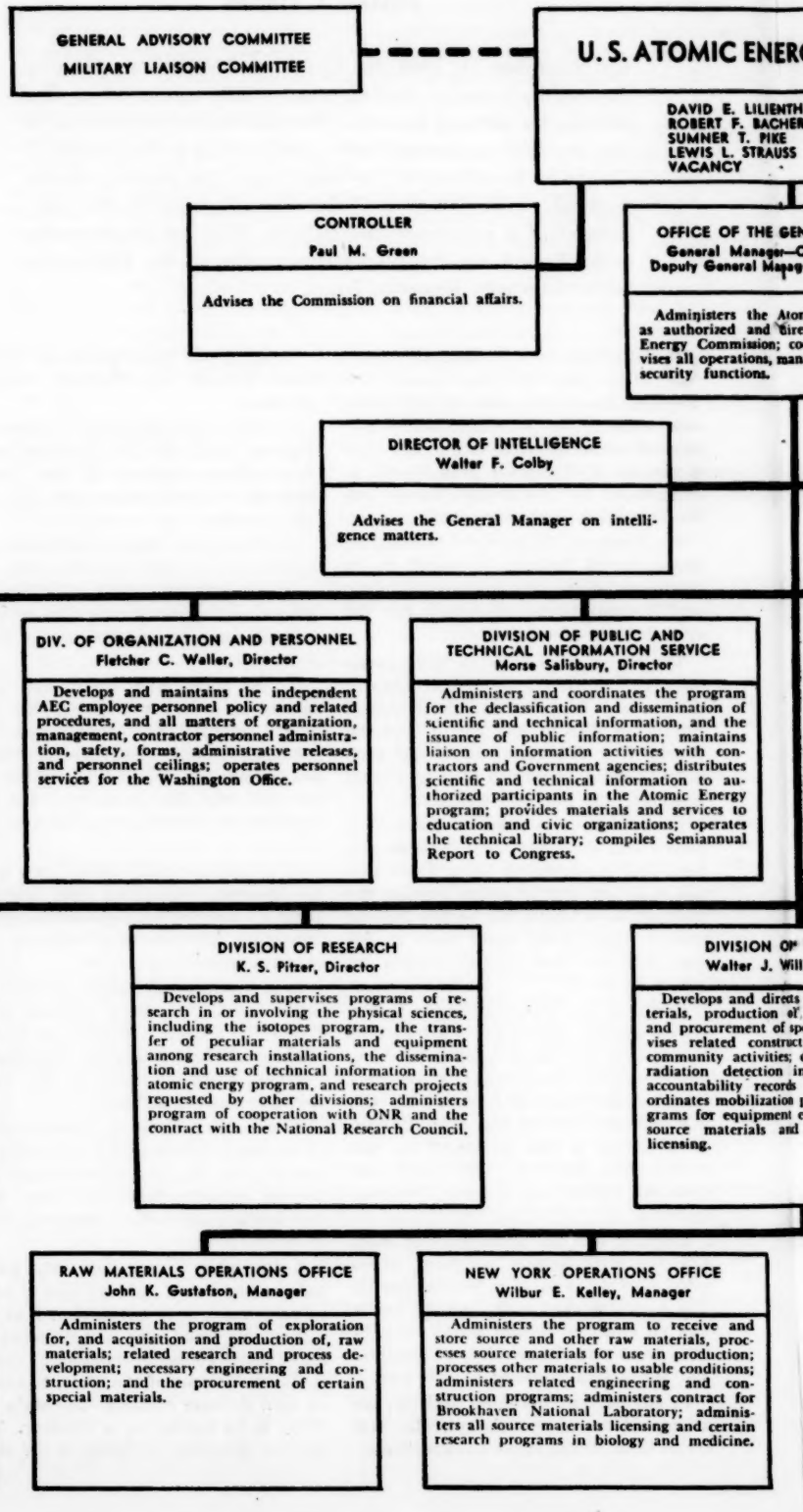
GENERAL ADVISORY COMMITTEE
MILITARY LIAISON COMMITTEE
U. S. ATOMIC ENER
DAVID E. LILIENTH
ROBERT F. BACHER
SUMNER T. PIKE
LEWIS L. STRAUSS
VACANCY
CONTROLLER
Paul M. Green
Advises the Commission on financial affairs.
OFFICE OF THE GE
General Manager—C
Deputy General Manag
Administers the Ato
as authorized and dire
Energy Commission; co
vises all operations, man
security functions.
DIRECTOR OF INTELLIGENCE
Walter F. Colby
Advises the General Manager on intelli-
gence matters.
DIVISION OF FINANCE
Paul M. Green, Controller
Under the direction of the Controller, plans, develops, and maintains policies and systems of accounting, auditing, and budgeting involved in the collection and disbursement of public funds, and for programs concerning records, transportation, communications, space and the procurement, custody, and disposition of materials, equipment, supplies and real estate; plans, develops, and maintains procedures for program authorization and progress reporting; performs business management services for the Washington Office.
DIV. OF ORGANIZATION AND PERSONNEL
Fletcher C. Waller, Director
Develops and maintains the independent AEC employee personnel policy and related procedures, and all matters of organization, management, contractor personnel administration, safety, forms, administrative releases, and personnel ceilings; operates personnel services for the Washington Office.
DIVISION OF PUBLIC AND TECHNICAL INFORMATION SERVICE
Morse Salisbury, Director
Administers and coordinates the program for the declassification and dissemination of scientific and technical information, and the issuance of public information; maintains liaison on information activities with contractors and Government agencies; distributes scientific and technical information to authorized participants in the Atomic Energy program; provides materials and services to education and civic organizations; operates the technical library; compiles Semiannual Report to Congress.
DIVISION OF REACTOR DEVELOPMENT
Lawrence R. Hafstad, Director
Develops and directs the program for the development of reactors, including the equipment and processes which will make possible their effective and safe use; integrates into this program special needs of other divisions.
DIVISION OF ENGINEERING
Roger S. Warner, Jr., Director
Handles special engineering and related problems for the Division of Reactor Development.
DIVISION OF RESEARCH
K. S. Pitzer, Director
Develops and supervises programs of research in or involving the physical sciences, including the isotopes program, the transfer of peculiar materials and equipment among research installations, the dissemination and use of technical information in the atomic energy program, and research projects requested by other divisions; administers program of cooperation with ONR and the contract with the National Research Council.
DIVISION OF
Walter J. Will
Develops and directs
terials, production of
and procurement of sp
vises related construct
community activities;
radiation detection in
accountability records
ordinates mobilization
grams for equipment
source materials and
licensing.
CHICAGO OPERATIONS OFFICE
A. Tammaro, Manager
Administers assigned portion of the program of reactor development; administers the contract for a research and development program at the Argonne National Laboratory; administers related contracts.
RAW MATERIALS OPERATIONS OFFICE
John K. Gustafson, Manager
Administers the program of exploration for, and acquisition and production of, raw materials; related research and process development; necessary engineering and construction; and the procurement of certain special materials.
NEW YORK OPERATIONS OFFICE
Wilbur E. Kelley, Manager
Administers the program to receive and store source and other raw materials, processes source materials for use in production; processes other materials to usable conditions; administers related engineering and construction programs; administers contract for Brookhaven National Laboratory; administers all source materials licensing and certain research programs in biology and medicine.

ENERGY COMMISSION
RGANIZATION CHART

February, 1949

OMIC ENERGY COMMISSION

AVID E. LILIENTHAL, CHAIRMAN
OBERT F. BACHER
IMNER T. PIKE
WIS L. STRAUSS
ACANCY

JOINT COMMITTEE ON ATOMIC ENERGY

ICE OF THE GENERAL MANAGER
neral Manager—Carroll L. Wilson
ty General Manager—Carleton Shugg

inisters the Atomic Energy program thorized and directed by the Atomic Commission; coordinates and super- ll operations, management services, and y functions.

GENERAL COUNSEL
Adrian S. Fisher

Advises the Commission regarding the interpretation of the Atomic Energy Act of 1946 and other sources of legal powers.

SECRETARY TO COMMISSION
Roy B. Snapp

Processes documents to be presented to the Commission, maintains official minutes and records of meetings; and provides related services.

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DIVISION OF SECURITY
Rear Adm. John E. Gingrich, USN, Director

Develops and maintains policies, standards, and procedures to assure the safekeeping of restricted data and other classified matter; to assure the protection of installations and materials of AEC; maintains liaison with the FBI, the National Military Establishment, and other agencies as required for the protection of restricted data and for the clearance of personnel; operates the security program for the Washington Area.

LEGAL DIVISION
Adrian S. Fisher, General Counsel

Under the direction of the General Counsel, advises the General Manager and his staff on all matters of law and legal policy; directs all patent activities.

DIVISION OF PRODUCTION
Walter J. Williams, Director

velops and directs programs of raw ma- s, production of fissionable materials, procurement of special materials; super- related construction, engineering and unity activities; develops and procures tion detection instruments; maintains ntability records of SF materials; co- ates mobilization plans; administers pro- s for equipment export control and for e materials and production facilities ing.

DIVISION OF BIOLOGY AND MEDICINE
Dr. Shields Warren, Director

Develops and supervises programs of research in biology and medicine; supervises measures to guard the health of atomic energy employees and the public; cooperates with the Division of Research in the isotopes program and administration of the contract with the National Research Council for a fellowship program; cooperates with ONR in support of basic research relating to biology and medicine.

DIVISION OF MILITARY APPLICATION
Brig. Gen. J. McCormack, Jr., AUS, Director

Directs the research, development, production and testing of atomic weapons; maintains liaison between the AEC and the Armed Forces; manages related AEC installations and communities.

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OAK RIDGE OPERATIONS OFFICE
John C. Franklin, Manager

Administers the programs for the production and development of U-235, special materials and fabricated items; administers the contract for the research program at Oak Ridge National Laboratory; manages the community of Oak Ridge; administers associated engineering and construction programs; administers isotope production and distribution.

HANFORD OPERATIONS OFFICE
F. C. Schlemmer, Manager

Administers the programs for the production of plutonium, special materials, and fabricated items; manages Richland Village; administers related engineering and construction programs.

SANTA FE OPERATIONS OFFICE
Carroll L. Tyler, Manager

Administers assigned programs in the field of atomic weapons; manages the community of Los Alamos; administers related engineering and construction programs.

AEC FIFTH SEMIANNUAL REPORT: PART II

The **Bulletin** here presents a condensed version of the chapters in the Fifth Report dealing with research in the physical sciences, biology and medicine, information services, and security. The earlier chapters of the Report were published in the March issue.

III. RESEARCH IN THE PHYSICAL SCIENCES

THE research program of the AEC is carried on for the most part at the large AEC laboratories: Argonne, Brookhaven, Oak Ridge, Los Alamos, Ames, the Radiation Laboratory at Berkeley, and the laboratories connected with production plants, such as the Hanford Plutonium Works, the K-25 gaseous diffusion plant, and the Y-12 plant at Oak Ridge. Other centers of research include the National Bureau of Standards, Columbia University, the University of Wisconsin, the Battelle Memorial Institute, the Massachusetts Institute of Technology, the Carnegie Institute of Technology, the Illinois Institute of Technology, the Sylvania Electric Company, and the Institute for Advanced Study, Princeton, N. J.

A good share of the year's effort went into providing the men and machines for the nation's atomic energy enterprise. The National Research Council undertook a large AEC-supported fellowship program, and all of the Commission's laboratories moved toward making themselves into regional training centers. At all AEC centers, research buildings and the expensive equipment of nuclear science—nuclear reactors, particle accelerators, and the like—were either being built or well advanced in plans.

The radioisotope training program at the Oak Ridge Institute of Nuclear Studies was one of the outstanding programs of the year. During the first six months of its operation, 128 scientists from 99 institutions in 32 states attended four-week, intensive courses in the use of tracer isotopes for research. Three courses are scheduled for the first quarter of 1949.

Late in 1948, the Commission issued a general list of unclassified areas of research related to atomic energy.

In general, the nonclassified areas of research include basic chemistry, physics, and mathematics, except for weapons physics and the nuclear and chemical properties of specific elements of special interest to the national atomic energy program; medical and biological research, and health studies, except for work with elements of atomic number 90 and above; instruments, including counters, and accelerators, with minor exceptions; and the chemistry and technology of fluorine compounds, except their specific applications in Commission installations.

Between November, 1947, and November, 1948, close to 2,000 research reports (including 210 concerning biology and medicine) were produced in the laboratories of the Commission and its contractors. More than three-quarters of the reports produced were of the nonpublishable kind. The degree of secrecy of research work varies widely from laboratory to laboratory. In the laboratory of the Hanford works, for example, only 2 out of 158 reports were of the publishable kind, and at Argonne laboratory, only 11 out of 132; whereas, at Brookhaven laboratory, which the Commission now plans to keep as free as possible of security restrictions so that wide academic participation will be possible, 40 out of 46 reports were publishable.

For further advance in the pure sciences, which must precede industrial application, it is necessary in these postwar years to keep a large and growing crew of physicists and chemists experimenting, gathering more data, and reflecting on the facts observed and recorded. It is this fundamental endeavor that the Atomic Energy Commission is helping to support.

The reason why the Government today assumes such a prominent part in providing the facilities for physical research is that the problems before nuclear physicists and chemists require the work of men in large teams and the use of very expensive instruments—machines such as the multibillion volt particle accelerators the AEC is building at the Radiation Laboratory at Berkeley ($9,000,000) and at Brookhaven ($3,475,000) and the nuclear reactor nearly finished at Brookhaven ($21,600,000).

These facilities and their operating groups are at the disposal of university and industrial scientists. The Commission also finances a wide range of studies on campuses and in industrial laboratories using privately-owned facilities. Research work done on two-thirds of the forty-odd particle accelerators in the United States is financed in whole or in part by the Commission.

The reason for this widespread and costly scientific fact-hunt basically is that our understanding of the atomic nucleus is today all too inadequate. Though we have learned how to obtain energy in quantity from the nucleus of the atom of uranium and plutonium, we do not know the origin of the forces which hold the atomic nucleus together and hence govern the release of energy. Scientists today can offer no explanation of most of the properties they have found the atomic nuclei to possess—such as their spin or their magnetism.

Present nuclear theory is probably at about the same stage as was the theory of atomic structure seventy years ago when the experimenters had begun to gather facts about atomic energies by tabulating spectral lines. In another twenty to thirty-five years, the genius of Rutherford, Max Planck, and Bohr set up theories about the structure of the atom and fixed energy levels which were found to give meaning to the observed facts.

It is the hope that the data now being gathered will in the same way lead in the not too distant future to a fruitful theory of the atomic nucleus.

Physics

IN 1948, the major part of the Commission's physical research funds was used to support work in physics, particularly nuclear physics.

The most extensive field of data accumulation comprises the study of what happens when the fundamental particles of the atom collide with one another or with the nuclei of varying

forms (isotopes) of the atoms. Finding these facts is the purpose of the research work done with particle accelerators—synchrotrons, cyclotrons, betatrons, Van de Graaff generators, and linear accelerators—and with nuclear reactors, or piles. In this way, the scientists are building the complete record of the nuclear reaction cross sections[1] of more than 700 isotopes of the elements when each is struck by nuclear particles of varying energies—a description of great importance to the physicist and the engineer. Nuclear reaction cross sections tell them what materials to choose for the structural frame, the control rods, the cooling gases or liquids, and the shields of the nuclear reactors which we hope one day will light our homes, power our industry, and possibly drive ships and airplanes.

BACK of this and other immediate practical applications lies the use of data of this fundamental sort for the development of new theory of the structure and the behavior of atomic nuclei.

But for whatever purpose the scientists and engineers wish these data, the scientists must first collect them, by bombarding the nuclei of a target material with a beam of particles coming from one of the small or great machines of present-day nuclear research.

At present, the entities most useful for bombarding nuclei are protons, deuterons (Hydrogen 2), Tritium (Hydrogen 3), Helium 3, alpha particles (Helium 4), gamma rays, mesons of several varieties, neutrons, and electrons. Since the type of nuclear reaction that occurs and the probability of its occurrence vary with the energy of the bombarding particle, it is necessary to work over a great range of energies, say from one thousandth of an electron volt to several billion electron volts. Moreover, it is desirable for the energies of the bombarding particles to be known and monochromatic; i.e., all of the same energy. If the bombarding particle has a charge, the energy of the beam may be raised to any desired level by one of the various types of particle accelerators. The neutron is chargeless so that it cannot be accelerated by a particle accelerator.

High-energy neutrons are most readily obtained by using a particle accelerator to bombard a suitable target material with a charged particle such as the proton, deuteron, or alpha particle. The neutrons are emitted from the reaction between the bombarding particles and the target.

The nuclear reactor provides an abundant source of low-energy neutrons.

The Commission has reactors now available for general research at Oak Ridge and Argonne. These facilities are open to men and women of industries and colleges and universities. No universities or industries possess such machines.

Scientists need to measure cross sections of neutron-bombarded nuclei, since neutrons are released in nuclear reactors and in atomic bombs and bring about the great output of energy in these machines. To make possible measurements, with monochromatic neutrons, a variety of instruments—the mechanical velocity selector, the crystal spectrometer, the "pile oscillator," and the use of the modulated beam technique have been developed or improved during and since the war.

In addition to the measurement of neutron cross sections at Argonne, Oak Ridge, and Columbia University, investigations of neutron reactions are being carried on at Los Alamos, the University of California at Berkeley, and other institutions under contract with the Commission.

Directly connected with the development of the atomic energy industry has been the investigation of the behavior of all uranium and other fissionable isotopes as a function of neutron energy. Most of this work is classified.

DURING the past year at the Radiation Laboratory at Berkeley the 184-inch cyclotron, the most powerful in the world, used in bombardment of a variety of target materials, produced reactions not before observed by nuclear physicists. In two fields important new phenomena were recorded:

1. New examples of an unusual reaction in which target material bombarded by protons gave off deuterons.

2. The production of Nitrogen 17, by bombardment of heavier elements with deuterons; and the measurement of its rate of decay to a new neutron-emitting isotope, Oxygen 17.

At Los Alamos, a search was made for cases of triple fission, where the atomic nucleus splits into three comparable masses instead of two. Triple fission of Uranium 238 by fast neutrons was found to take place less frequently than once in every 4,000 binary fissions. Triple fission of Uranium 235 by slow neutrons was found only about once in every 300,000 binary fissions.

IT IS believed that particles known as mesons have an intimate connection with nuclear forces. Physicists first observed mesons twelve years ago on photographs taken of the interaction of cosmic rays with various nuclei. They had a mass approximately 200 times that of the electron. Since then, researchers have found heavier mesons and have determined that mesons apparently may have a positive charge, a negative charge, or none at all.

The Commission and the Office of Naval Research are supporting jointly a number of cosmic ray studies devoted to finding more about these particles. At the University of Minnesota scientists have sent cloud chambers attached to balloons up to altitudes of 100,000 feet. Photographs taken at such heights reveal, in addition to mesons, many types of particles approaching the earth from outer space, including nuclei of middleweight elements such as copper.

Early in 1948 scientists reported the first artificial production of mesons in the 184-inch cyclotron. This was accomplished by bombarding various targets with 400-million electron-volt alpha particles.

Now with hundreds of millions of times more mesons available than occur in cosmic ray observations—and available under controlled laboratory conditions—scientists are on the track of understanding the processes by which mesons are formed and disappear. They measured at 1.22-hundred-millionths of a second, the mean time of the heavy meson's decay into the lighter meson. They measured the masses of these two particles with far greater precision than before. They found the heavy meson to have a mass 284 times that of the electron, while the light meson is 215 times heavier than the electron.

THE most important advance in radiation-measuring instruments made during the year was the improvement of "solid scintillation counters," which detect gamma rays, fast neutrons, and alpha particles.

When a particle impinges upon certain crystals, notably stilbene and anthracene, a flash of light of short duration results. This flash can be picked up and amplified by a photomultiplier tube, thus translated into an electric pulse which can be registered upon earphones or a mechanical counter.

Although much research remains to be done to perfect this type of instrument, it is expected that it can be de-

[1] The "cross section" indicates the probability that a given nuclear reaction will take place. The cross section measures the size of the "bull's-eye" or nuclear target, which is an important factor in whether a "hit" or reaction occurs.

veloped into a radiation counter of extreme lightness and compactness as compared to existing instruments for similar purposes.

Work on the solid scintillation counter is going on at Berkeley, Argonne, Los Alamos, Brookhaven, and Oak Ridge.

The total magnetic moment of a system should be equal to the sum of the moments of the individual parts. However, Argonne scientists in 1947-48 found by very precise measurements that tritium (Hydrogen 3) which has one proton and two neutrons, and Helium 3, which has one neutron and two protons, have magnetic moments about 10 per cent higher than the expected values. This additional magnetic moment may arise from the electric current which is produced when protons and neutrons exchange their identities. Scientists believe this exchange current to be associated with the presence of mesons in the nucleus. There are many gaps, however, in present knowledge.

Other types of research on magnetism of various materials have been conducted at Argonne. When a beam of neutrons is sent through magnetized iron, it becomes polarized, i.e., the neutrons are oriented so that their magnetic moments line up in the same direction; the production of polarized neutron beams by magnetized iron has been investigated during the year, and a relation between the extent of polarization and the magnetic saturation of iron has been worked out.

CONSIDERABLE work has been done at Argonne and Oak Ridge on the changes in physical properties of materials that follow intense neutron radiation. The latter causes disordering of the arrangements of atoms in crystals. Further experiments will be made to determine what effect such changes have on the strength, resistance to heat, and other properties of metals.

The electromagnetic separation plant (Y-12), at Oak Ridge, has not been in operation for the production of Uranium 235 since shortly after the end of the war. However, the equipment at Y-12 has been used to separate isotopes of other elements. By the close of 1948, the naturally occurring isotopes of thirty-five nonfissionable elements had been concentrated electromagnetically at Y-12. Work is proceeding on other elements. A group of researchers at Y-12 is surveying the physical and chemical properties of stable isotopes. The contribution to fundamental knowledge already is great and is growing steadily.

Chemistry

MUCH research in chemistry financed by the AEC has to do with the chemistry of the heavy elements, the knowledge of which is needed to solve the problems of production and handling of fissionable materials.

At Berkeley, work continued during 1948 with the large cyclotron on extending knowledge of the new man-made elements above plutonium. Similar work on isotopes of the heavy elements produced by neutron bombardment in reactors was carried on at Argonne and Oak Ridge.

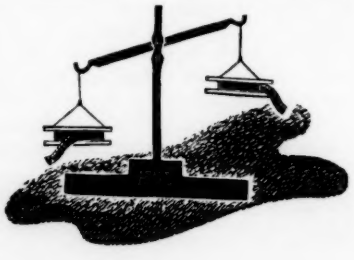
Chemists in many Commission-supported laboratories are investigating a new field, the so-called "hot atom" chemistry. Many nuclear reactions change one element into another having different chemical properties, and scientists have observed some remarkable results. For example, when chlorine in potassium chloride is converted to sulfur, the product actually isolated is potassium sulfate. The sulfur has been oxidized to sulfate under conditions where oxidation normally does not occur—apparently, because of the large amount of energy evolved in the nuclear reaction.

Men are working on various "hot atom" chemistry problems in laboratories at Argonne, Brookhaven, and Oak Ridge, at Massachusetts Institute of Technology, at Los Alamos, and at Knolls Atomic Power Laboratory, Schenectady, N. Y.

Scientists at Argonne, Ames, Oak Ridge, the Radiation Laboratory, the National Bureau of Standards, and others have developed new methods of purification and analysis in order to determine whether zirconium can be made into useful material for reactor construction.

The Ames Laboratory is continuing studies on chemical separation processes in which the chemicals to be separated stick to organic resins or transfer from one liquid to another as the liquids flow through a resin column.

Problems encountered in the recovery of thorium and uranium from waste products are under examination at Ames as well as at Argonne and Oak Ridge. The possibilities of obtaining thorium and pure rare earths from monazite by new processes are under investigation.



The Chemistry Division at Argonne also is working on the development of separation techniques for pile-irradiation products and the development of satisfactory pile materials.

Training Program

THE war produced a sharp cut in the number of students normally graduated in the physical sciences. The nation has lost a reservoir of scientific manpower that will have to be slowly replenished.

The Commission through the National Research Council of the National Academy of Science had awarded by mid-December 162 fellowships in the physical sciences assigned to 40 different educational and research institutions in 21 states. The stipends vary between $1,600 and $2,400 per year for predoctoral, and between $3,000 and $4,000 per year for postdoctoral studies.

The Commission's three national laboratories—Argonne, Brookhaven, and Oak Ridge—offer opportunities for special research and advanced study by university staff members, by students who have completed their doctorate training, and by industrial research workers.

Located as they are in the Northeast, Southeast, and Midwest, they have enlisted the active participation of fifty-eight universities and research institutions. In them the university scientists —physicists, chemists, metallurgists, mathematicians, biologists, medical men —can work full time or part time, or as advisers or consultants, and can attend meetings and keep in touch with developments.

The Los Alamos laboratory engages both in atomic weapons development and in fundamental research; AEC research is also carried on at the Radiation Laboratory at Berkeley, at Hanford, at Schenectady, and at the Mound Laboratory at Miamisburg, Ohio, operated by the Monsanto Chemical Company. A new laboratory is being fitted out at New Brunswick, N. J. for analyzing feed materials used in production of fissionable materials.

The Commission has contracts with the Battelle Memorial Institute in Columbus for metallurgical research and with Columbia University for nuclear research which is largely unclassified.

Late in 1947 the Commission and the Office of Naval Research arranged a program of joint support of basic scientific research in projects not involving classified data. The AEC now participates in thirty-two contracts of this type.

Production of Isotopes and Rare Earths

THE Commission's Fourth Report to the Congress was devoted primarily to the program for production, distribution, and utilization of isotopes.

Since then, the AEC Isotopes Division at Oak Ridge made available two more isotopes, Hydrogen 3 (tritium) and Helium 3, to laboratories outside AEC projects. Tritium is radioactive, whereas Helium 3 is stable. Both are useful in physical and nuclear research. Tritium is a valuable adjunct to Carbon 14 for labeling organic tracer compounds.

Several applicants have proposed the use of large quantities of Cobalt 60 as gamma ray sources in experimental radiology and radiography. The Isotopes Division has begun the production of high specific activity cobalt and is working on the problems connected with utilization.

Both the Argonne and Oak Ridge National Laboratories have initiated "isotope farm" programs, one function of which will be the biological synthesis of organic compounds labeled with isotopes. In addition, private industry has entered the field of isotope-labeled compounds.

The Commission continued to distribute Phosphorus 32, Iodine 131, and Sodium 24 free to laboratories engaged in research on cancer and allied diseases. With the assistance of the National Bureau of Standards, the Commission began studies to standardize the measurements of radioactive Iodine 131 since wide variation in standards had been found to hamper establishment of uniform treatment procedures.

COMMISSION laboratories have developed production methods for rare earths of a purity and quantity previously unattained.

The wider availability of these little-known materials is of interest to scientists in many fields. It appears that they may have a commercial future as alloy metals in the manufacture of high-temperature structural materials and other specialized products.

In addition to a number of salts and oxides, the following pure metals were prepared in small quantities: (a) Pure lanthanum and cerium; (b) Neodymium; and (c) Didymium (approximately 80 per cent neodymium, 8 per cent samarium, 8 per cent praseodymium).

Information Exchange

TO FACILITATE cross-fertilization of ideas and effective exchange of information, the Commission has developed several procedures.

In 1948, the Commission defined certain broad fields of research related to atomic energy in which security restrictions are no longer considered necessary or desirable.[2]

Qualified scientists may now visit the locations of unclassified work and obtain information about it in the traditional way. Scientists performing unclassified research may discuss it freely with nonproject personnel. The results may be published in accordance with the traditional pattern of review by the laboratory director or his designated board of review.

Under the security principles necessary today, no person receives more classified information than that needed for the performance of the tasks entrusted to him. In practice, this restriction may work against progress, since often one person or group will be in possession of information of great value to others.

In 1948, a total of more than 1,600 new classified research and development reports were produced within the Commission. To facilitate the exchange of classified information among Commission installations, a system of standard distribution lists has been introduced. A total of 24 categories of technical information has been established, with an approved list of authorized recipients for each.

The Division of Research also maintains a small staff of technically trained personnel at Oak Ridge to review all new reports and authorize additional distribution where necessary.

As a supplement to this information-exchange program, the Commission prepares two semimonthly documents, with the cooperation and authorization of the Division of Research: (1) a title-and-author list of all classified reports published during the preceding period and (2) Abstracts of Classified Documents, in which abstracts or content notes on all new reports published during the preceding period are given.

Both documents receive wide circulation to all Commission installations and contractors.

Two large information meetings were held during 1948, and symposia on specialized subjects were also held from time to time.

Atomic energy information meetings have the same function and are handled in the same general fashion as national meetings of the chemical, physical, and mathematical societies, but only classified papers are presented and admission is restricted to "cleared" personnel.

Technical Cooperation

DURING 1948, the program of technical cooperation among the United States, Canada, and the United Kingdom has continued in such general areas as health and safety, research with low power reactors, extraction chemistry, stable isotopes and radioisotopes, and the problems of raw materials.

This program is carried out under the general direction of the Combined Policy Committee, which was established early in the period of wartime development, in August, 1943.

With the passage of the Atomic Energy Act of 1946, the wartime cooperation between the three Governments had to be viewed in the light of the responsibilities fixed by Congress upon the Commission as well as of considerations of foreign policy and national defense.

The general framework thus provided has been utilized to develop technical consultations on specified topics and to provide for a number of visits by scientists and technicians of each country to the other two.

The exchange of research experience and the mutual availability of stable and radioactive isotopes is another field in which benefits derive to each of the three nations.

In connection with the development of research reactors, fundamental knowledge about reactor materials, and work in the field of extraction chemistry, the United States, as well as Canada and the United Kingdom, can share some degree of experience to achieve mutual benefit to all three Governments.

IV. BIOLOGY AND MEDICINE

PHYSICIANS who have used X-rays and radium for the treatment of disease, have become familiar with the harmful effects of overdoses of radiation. What was new in atomic energy development was the massive quantity of radioactive materials created. The Atomic Energy Commission must explore the many benefits and must learn how to forestall dangers to human, plant, and animal life.

[2] See pages 121-122 of this issue.

In 1947, the Commission, as a first step in meeting its responsibilities, designated an Advisory Committee for Biology and Medicine. This committee assisted in the establishment of a Division of Biology and Medicine in the Washington staff of the Commission.

The biological and medical activities of the wartime project had been highly compartmentalized. During 1948, the Commission made considerable progress in coordinating the biological, medical, and biophysical activities at the various facilities.

The Manhattan project established a research project at the University of Chicago as a part of the Metallurgical Laboratory to determine the effects of plutonium and of various radiations on the body. The Commission has expanded this program at Argonne to embrace a variety of cancer studies and the application of radioisotopes.

ALL AEC laboratories have enlarged their research programs during 1948—at Brookhaven chiefly for the study of the uses of atomic energy in the understanding, diagnosis, and treatment of disease; at Oak Ridge, for the investigation of the effects of radiations on plants and lower animals; at Hanford, for the determination of the effects of radiation and radioisotopes on aquatic organisms; and at Los Alamos, for the solution of the biological and medical problems connected with the development and assembly of atomic weapons.

During 1948, also, the Commission renewed, enlarged, or initiated contracts for projects in biology and medicine at the following institutions: the universities of Rochester, California, Western Reserve, and Columbia for basic studies of the effects of radiation on life processes and reproduction; Memorial Hospital and Sloan Kettering Institute in New York, Washington University in St. Louis, Harvard University, the universities of Oregon and California, and, a number of other institutions and AEC laboratories, for cancer studies; University of Washington, University of Tennessee, U.S. Department of the Interior, and other institutions, for investigation of the effects of radioactive materials on wildlife and livestock; and U.S. Department of Agriculture and a number of state agricultural experiment stations for experimentation on the effects of radiation on plant life.

The Commission, early in 1948, took over from the Office of Naval Research the financial support of some twenty-eight projects. Since that time it has selected and furnished funds for some seventy projects covering a wide range. At Harvard and M.I.T., for example, AEC-supported research workers have used radioisotopes in studying the chemical constitution of the blood cells in a variety of diseases. At Washington University, biologists have developed methods for preparing artificially certain substances contained in living cells and their nuclei. And at the California Institute of Technology, the University of Colorado, and Reed College, Portland, Oregon, other workers are finding the explanation of many of the previously unknown facts about the synthesis of proteins.

Also, the Commission arranged for the creation of training centers in thirteen universities and for active training programs in its own laboratories. At the University of Rochester, the Commission began construction of major training and laboratory facilities; it approved for construction at Chicago a cancer hospital to be operated by Argonne in connection with the University of Chicago's own program.

To stimulate research and education in the biological and medical aspects of atomic energy, the Commission, in 1948, arranged meetings, at Brookhaven (July 12-30), on the biological applications of nuclear physics (attended by more than 40 university scientists), at Oak Ridge, in March (attended by more than forty institutions which sent from one to ten representatives each), and at Argonne, in October, at which radiation exposure problems were discussed.

Biology

IN THE field of biology, the Commission is supporting research dealing with the effects of radiation on plant and animal life. Large-scale studies are being made of the absorption by plants from the soil of a variety of radioactive elements, of their localization in plants, and of their effects on animals fed with these plants.

The question of whether radioactive materials stimulate the growth of plants is an old one; with the new plentifulness of such materials it has become a very practical one. Early in 1948, the Commission arranged for the Department of Agriculture and a number of state experiment stations to conduct experiments in fourteen states on the effects of small amounts of radioactive materials on nineteen different crops, including sweet potatoes, cotton, corn, soybeans, oats, alfalfa, tomatoes, turnips, navy beans, table beans, spinach, etc.

These one-season field experiments indicate that the farmer cannot expect increased yield from adding radioactive materials to the soil. A second series of tests will be run in 1949.

These studies are quite distinct from the fertilizer tracer research, where radioactive isotopes are being used to gain understanding of the movement of fertilizer in the soil, of its absorption and localization in plants. Such studies are expected to solve practical problems of direct interest to farmers, fertilizer producers, and farm machinery manufacturers.

A PORTION of the biology program is devoted to the effects of radiations on living cells, with special emphasis on chromosomes and inheritance. It has long been established that radiations can cause "mutations," that is, interfere with the normal workings of heredity. All Commission laboratories and a number of universities under contract are conducting research on this subject, which has tremendous implications, both good and evil, in an atomic age.

Test organisms include higher plants, animals, molds, and bacteria. Bacteriophage viruses and enzyme systems are also being studied.

The Oak Ridge Laboratory has embarked on an extensive study of the genetical effects on mice of exposure to nuclear radiations. In ten years of work with mice, biologists can observe about fifty generations — a genetical history that would require a 1,000-year span in human life.

On July 16, 1945, in New Mexico, a herd of cattle was accidentally exposed to the radiation of the first atomic bomb. Today, biologists of the University of Tennessee, in cooperation with the Commission, are studying the breeding records of some of these same cattle and comparing them with normal animals.

Also, the Tennessee workers are preparing to feed farm animals radioactive materials and to observe the retention of radioactivity by the body tissues, to learn whether the milk and meat of such animals is fit for human consumption. They will feed the meat to rats through several generations and observe how the test rats are affected by this diet. They will record such symptoms of low-level radiation injury as altered reproduction, progressive changes in weight, blood composition, and tissue and bone structure.

In test atomic bomb explosions the medical and biological scientists are concerned first of all with the immediate victims in the plant and animal kingdoms. Surviving specimens provide information regarding recovery phe-

nomena, and, should any produce offspring, on genetic changes.

Just as interesting, however, are the data on the lingering radioactivity produced by underwater or land explosions, and its effects on plants and animals. The uptake of radioactivity by organisms and its accumulation in certain parts of the body comprise an important field of investigation.

The Commission's New Mexico survey was undertaken under a contract with the University of California at Los Angeles. There appear to be no appreciable hazards of external radiation for men or livestock at the New Mexico bomb site outside of the fenced area of several hundred acres surrounding the place of explosion.

In August, an expedition sponsored by the Commission, with the assistance of the Department of the Navy, completed a survey of the effects of the atomic explosions on marine plant and animal life at Bikini and Eniwetok in the Pacific Ocean. The survey was conducted by twelve men under a contract with the School of Applied Fisheries, University of Washington.

The results of the previous survey of Bikini in the summer of 1947 will be combined with the results of this summer's survey to provide a continuing picture of the effects of the 1946 Bikini atomic bomb tests. Aquatic fauna and flora samples were gathered for laboratory analyses. It is too early to present any conclusions on the aftereffects of atomic explosions on plant and animal life. Further studies are being planned.

An important step in the application of isotopes to biology is the preparation of biochemical compounds. AEC scientists at Argonne and Oak Ridge and elsewhere have been developing the interesting method of administering radioisotopes to plants and animals and allowing the living organisms to synthesize them into compounds which then may be extracted and used as tracers.

Compounds produced include radioactive sugars, starches, amino acids, drugs, and cellulose.

Jerusalem artichokes or sugar beets growing in an atmosphere containing radioactive carbon dioxide gas develop radioactive sugar. The foxglove plant can be made to produce radioactive digitalis; radioactive casein has been produced by cows.

Medicine

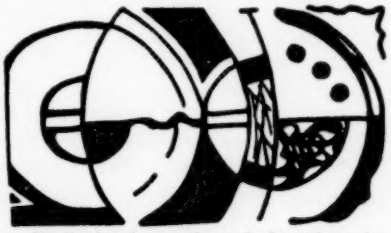
THE MEDICAL program of the AEC concentrates upon the effects of radiation, and of certain new elements and unfamiliar substances, upon human health. Seeking to understand and prevent the harmful effects of radiation is only part of the task; equally important are the potentialities for better understanding of diseases, for more accurate diagnosis, and in a few cases, for cure.

One of the most pressing responsibilities is to find out as much as possible about the injuries that radiation inflicts upon the human body, how to diagnose the injuries as early as possible, and how to treat them.

At Los Alamos, biologists and medical men are searching for the subtle changes in cell multiplication characteristic of the effects of low-level radiation. They look for alterations in the composition of the blood of workers who may have been slightly exposed.

Argonne laboratory is observing the lowering of blood pressure and changes in the nitrogen content of the blood. Oak Ridge laboratory and Argonne are both studying alterations in the enzyme systems believed to be affected by radiation. It is hoped that through these studies tests may be developed for detecting early radiation injury.

At Rochester a number of drugs and hormones are being tested for their effect in ameliorating this injury.



Radiation is not the only health problem involved in atomic energy work. Thus the element beryllium which may be used as a "moderator" in nuclear reactions is now recognized as able to cause acute and chronic lung disease, and cases have developed in employees of private companies from whom the AEC purchases beryllium. In 1948, the Commission initiated studies regarding permissible concentration of beryllium, prevention of injury, diagnosis, and treatment. As a result authorities now predict that over 90 per cent of the hazard can be removed.

The element plutonium may cause serious damage to the liver, kidney, and bone marrow if enough of it gets into the blood stream. Scientists at Los Alamos have developed a test to measure plutonium excreted from the body and thus to keep watch over personnel in danger of exposure. Argonne laboratory has demonstrated that the relatively harmless element zirconium will displace plutonium in the body and thus eliminate it.

Cancer Program

THE Commission's program deals with all of the relationships between radiations and cancer. First, exposure to radiation may induce cancer; radiologists in the past have contracted leukemia, a cancerous abnormality of the blood, and research workers are now inducing cancer in experimental animals with radioisotopes. Second, radioisotopes are teaching biologists new facts about the nutrition of cancerous cells. And, third, medical men now use radioisotopes to diagnose the existence of cancer and, to a limited extent, to treat some of its forms.

Studies of fission elements such as radioactive strontium and of plutonium have revealed that several of these substances localize in bone and may produce bone tumors.

The Commission has developed its program along four major lines:

1. *The distribution without charge of radioactive phosphorus, iodine, and sodium for cancer research.*—Under this program, radioisotopes have been distributed to over a hundred hospitals, medical schools, and clinics in the United States.

2. *Financial and scientific support for selected research projects in the cancer field.*—AEC-sponsored research at the Memorial Hospital, New York City, has made an advance in the treatment of thyroid cancers with radioiodine. Metastatic thyroid cancers, i.e., cancers that spread through the body, may pick up radioiodine in amounts sufficient to destroy the tumor partially or perhaps completely.

One of the most interesting applications in the cancer field lies in the use of radioactive compounds in the detection of cancer. Various compounds are being labeled with radioisotopes, and their uptake by various tumors studied, with the anticipation that a compound will be found that will be of diagnostic assistance.

3. *Clinical cancer research facilities at the installations of the AEC.*—In the chain-reacting pile a number of radioisotopes may be prepared which are so short-lived that it is impossible to distribute them through the country. The AEC is establishing facilities at several of its laboratories where these short-lived radioisotopes may be studied. At Oak Ridge a clinical cancer research facility is being established. In November, 1948, a clinical director of the program was designated. The participating medical schools will refer here cancer cases for research, diagnosis, and

treatment. A similar facility is planned at the Brookhaven laboratory. At the Argonne laboratory a cancer research hospital is presently under construction.

The betatron in which electrons are accelerated, the high voltage cyclotrons now being developed, and the various modifications of these instruments require study in their relation to cancer. Workers in the clinical cancer research facilities of the AEC will carry out such studies along with a number of medical schools affiliated with the regional laboratories.

4. *The work of the Atomic Casualty Commission,* which includes studies on the incidence and types of cancer in the survivors at Hiroshima and Nagasaki.

The Atomic Casualty Commission

ON MAY 15, 1946, the Armed Forces Joint Commission for Investigating the Effects of the Atomic Bomb in Japan reported that investigation should be continued for a long time along the following lines: (1) Registry of exposed persons; (2) Establishment of a permanent American Control Commission to pursue further (a) Hematologic studies; (b) Studies in the sexual sphere, including sperm counts and genetic aberrations, and sterility; and (c) Studies of possible carcinogenic (cancer-producing) effects.

In November, 1946, the Secretary of the Navy recommended that the President:

> instruct the National Academy of Sciences, National Research Council, to undertake a long-range, continuing study of the biological and medical effects of the atomic bomb on man and authorize the council to enlist the aid of governmental agencies and personnel, and such civilian agencies and personnel as might be needed.

The AEC and the National Academy of Sciences signed a two-year contract in May, 1948, covering studies and conduct of research and experimental investigations, primarily in Japan, of physiological and biological effects of radiation.

Since May, 1948, there has been considerable activity in establishing facilities. At present, laboratories at Hiroshima and Kure are active, and the Nagasaki unit is developing rapidly. There are 41 Americans working in Japan, including 16 professional, and 15 technical workers. There are approximately 140 Japanese personnel, including physicians, technical assistants, and laborers.

The laboratory at Hiroshima has examined a large number of survivors. Practically all births and all deaths which occur are studied for any evidence of changes that might have been induced by radiation. A fairly complete list of exposed personnel has been accumulated, and in many instances it is possible to determine the approximate amount of radiation that they received at the time of the explosion. X-ray and detailed anthropometric studies are being conducted on the bones of exposed children.

These studies reveal many instances of "growth arrest" which could be due to nutritional deficiencies or could be related to the atomic explosions. These cases will be followed closely.

Thus far there has been no evidence of any alteration in the offspring of exposed individuals, nor any demonstrable increased incidence of still births or miscarriages. In view of the fact that the gene injured by radiation is a recessive characteristic which can be carried but is not necessarily manifested in the next or many generations, it will be many years before a final statement can be developed on this problem.

There has been a high incidence of keloids, i.e., overgrowths in the scars from thermal burns. Japanese exposed to the fire bombings at Tokyo also show a high incidence of these keloids, which are apparently a racial trait.

A long-term study of the effects of the atomic explosion on fertility is being undertaken. Survivors are also being studied for signs of cancer.

Biophysics

IN NEARLY all Commission work, hazardous radiations are a major problem. Although the biological effects of these radiations have been studied intensively for only a relatively short time, there is good reason to believe that they are entirely controllable hazards. During the entire period of operation of both the Manhattan Project and Atomic Energy Commission there have been a total of thirteen injuries, with only two deaths due to radiation, and in each instance available safety devices were not fully utilized.

The Applied Biophysics Branch was established in Washington to study (1) the detection of radiation; (2) shielding the operators; (3) the safe radiation dose to which operating personnel may be continually exposed; and (4) safeguards to protect the environment against radiation from atomic energy establishments.

All AEC installations conduct "health physics studies" to insure that the programs at the various installations are adequate for their own purposes; programs are coordinated to prevent unnecessary duplication.

Radiation hazards which must be controlled come from two major sources: (1) reactor and particle-accelerator operations including isotope production and the chemical treatment of radioactive isotopes; and (2) the disposal of waste containing radioactive material.

The majority of waste disposal problems are engineering in nature. However, the setting up of maximum permissible levels of radiation and the measuring of radioactivity in the waste are biophysics functions.

The Commission has surveys under way at all of its major installations to determine, for example, to what extent conventional waste disposal plants and water treatment plants are effective in removing radioactive materials. Oak Ridge, TVA, U.S. Public Health Service, and the Geology Department of the University of Tennessee undertook such a survey in 1948. At Los Alamos, the U.S. Public Health Service and the University of California are assisting in similar work.

At Brookhaven an extensive program is under way to study the area adjacent to the laboratory—the geological formations, water tables, meteorology, and animal life. The Weather Bureau and the U.S. Geological Survey are assisting. Monitoring stations for measuring the radioactivity have been constructed, together with two unique meteorological towers.

Cobalt 60 shows considerable promise as a cheap and plentiful substitute for radium. As soon as preliminary problems are solved, it is reasonable to expect that Cobalt 60 will be available for therapeutic purposes to a much larger number of medical centers than are now in a position to afford radium. Consequently, considerable effort is being put in this direction.

Training Program

THE shortage of scientific personnel qualified to work on atomic energy problems in biology, medicine, and biophysics made necessary the development of a training program.

Three hundred and fifty annual fellowships were established for postdoctoral research in the medical, biological, and agricultural sciences, for predoctoral study in the biological sciences, including health physics, and for training in health physics at the technical level. The Commission intends to make annual awards as follows: 100 postdoctorals in medicine; 50 postdoctorals in biology; 175 predoctorals in biology

and health physics; and 25 technical fellowships in health physics. By November, 1948, 27 medical postdoctoral, 5 biology postdoctoral, 48 predoctorals in biology and health physics, and 18 technical fellowships had been awarded. It is expected that in 1949 the program will be operating at its proposed level.

The Commission has given support during 1948 to at least two universities in each of four broad areas for the development of cooperative training centers, suited to train AEC fellows in the first semester in each academic year.

The participation by the universities allows for the utilization of their personnel and resources. As part of its training program, each of the universities is conducting research which is important to the Commission. The cooperating universities are as follows:

Region I includes: Duke University; University of North Carolina; North Carolina State College of Agriculture and Engineering; and Bowman Gray School of Medicine, Wake Forest College.

Region II includes: Baylor University College of Medicine, Houston, Tex.; and Rice Institute, Houston, Tex.

Region III includes: Oregon State College; University of Oregon Medical School; College of Liberal Arts, University of Oregon; and Reed College.

Region IV includes: University of Denver; University of Colorado, Denver; and University of Colorado, Boulder.

Eleven officers of the National Military Establishment are taking courses at the AEC training centers, to prepare for work in radiological safety with the armed forces.

The Commission is supporting training programs for technical fellows at University of Rochester Radiological Laboratories and at Oak Ridge. The program will consist of courses in biology, chemistry, mathematics, applied biophysics, industrial hygiene, and sanitary engineering, carried out over an 8- or 9-month period, supplemented by laboratory experience in the use of radiological instruments. Following will be a 3- or 4-month work program, where the fellows will be assigned to plant operations at Commission installations, and given training in radiation monitoring and health-physics techniques. It is estimated that there is need within the AEC alone for approximately 250 people having such training. It is accordingly planned to step up the training program next year in order more nearly to fill the demand.

V. PUBLIC AND TECHNICAL INFORMATION SERVICES

ON UNDERTAKING in 1947 the development of the information program prescribed by the act, the Commission took into account the needs of various groups for information. The scientific and technical workers in the employ of the Commission or of contractors require technical information, some of which is restricted data. This must be classified and distributed only to those requiring it in their duties. Some, after examination, may be declassified.

Scientists and technicians and business executives not directly associated with the Commission or its contractors increasingly require information, not only for their part in research and in development of atomic energy, but also for general advance in technology.

The American people need information on atomic energy developments. Facts are the only sound basis for citizens' decisions on national policies.

Measurable progress toward meeting these needs has been made in the past two years. Much, however, remains to be done.

The Declassification System

THE Commission took over from the Manhattan Project a declassification system established in 1946 pursuant to the report of a committee headed by the late Dr. Richard C. Tolman. The Tolman committee defined the principles for determining what matter can be declassified. Under this system, an official of the laboratory or plant where information originates makes the first determination as to its suitability for declassification. If this determination is favorable, the paper is then referred to a Responsible Reviewer qualified in the field with which the information deals. This reviewer makes an analysis based on the Declassification Guide. In case of doubt, the question is referred to one of four scientists designated as Senior Responsible Reviewers.

The Commission, starting in 1947, has taken a number of steps to clarify policies and guide information operations. These include:

1. Designation of unclassified fields of research related to atomic energy, which are generally free of any security restriction.

2. Two over-all revisions of the original Declassification Guide made jointly with the declassification authorities of the United Kingdom and Canada. These nations are following identical declassification policies with respect to information jointly held.

3. Adoption, with the National Military Establishment, of a joint classification guide for the military application of atomic energy, with provision for the handling of data primarily of a military operational nature.

4. Action to develop more precise and more flexible methods of determining what information must be withheld from general publication and what may be publicly issued.

The Commission has undertaken to designate unclassified areas as a means of aiding the progress of atomic energy research.

The Commission recognizes that advance depends in part upon research work done without assistance by government.

Staffing of atomic energy projects is hampered so long as there is feeling on the part of many scientists that employment precludes their working on any but "classified" research projects with consequent denial of general publication.

Finally, sharper definition of unclassified areas makes clearer what must be held restricted, and reduces the number of documents unnecessarily classified. Confusion is cut down, and security is enhanced.

It is the Commission's intention to define and announce further unclassified areas.

The AEC Declassification Guide at present lists some 60 categories under which information must remain classified; and an equal number of topics under which information can be released. Scientists and laboratory directors, applying the guide, have cleared for release more than 2,600 scientific and technical papers.

Unclassified Areas.—In general, the unclassified areas[3] cover the pure science related to atomic energy but not plant processes or specific experimental data of project importance:

1. Pure and applied mathematics, except that applying to specific classified projects.

2. Theoretical physics (except the theory of fission, of reactors, and of neutron diffusion, and weapon physics).

[3] The reader cannot take these lists as an exact statement of types of data which are unclassified, classified, or declassifiable. The complete lists, as stated earlier, are themselves classified. Writers, editors, publishers, or speakers intending to make public matter related to atomic energy, who are uncertain about classification status, should query the Declassification Branch, United States Atomic Energy Commission, Washington, D. C. They should not try to make their own evaluation on the basis of these partial listings.

3. All physical (except nuclear) properties of all elements of atomic number less than 90. Nuclear properties of most isotopes.

4. The basic chemistry of all elements (except for the analytical procedures and technology of the production of fissionable materials) and the physical metallurgy of all elements of atomic number less than 83.

5. Instrumentation, including circuits, counters, ionization and cloud chambers, neutron detectors (excluding fission chambers), electronuclear accelerators, such as cyclotrons, betatrons, Van de Graaff generators, etc.

6. Medical and biological research and health studies (excluding work with elements of atomic number 90 and above).

7. Chemistry and technology of fluorine compounds (except the specific applications in AEC installations).

Declassifiable Information.—The declassifiable information which may be expected to be found in the general literature after official declassification, includes:

1. Most reactor and neutron diffusion theory, except for those parts involving semiempirical methods or related to specific assemblies.

2. Certain physical properties of isotopes of elements of atomic number greater than 90, and the nuclear properties (except for certain neutron and fission characteristics) of isotopes of elements greater than 90.

3. Analytical procedures (except for production applications); most physical and process metallurgy of elements of atomic number greater than 90.

4. Medical and biological research and health studies with elements of atomic number 90 and above.

5. Certain properties of experimental reactors, such as: fluxes, neutron distribution not revealing lattices and information regarding thermal columns, and the velocity spectrum in the thermal column.

Classified Information.

These types of information are clearly classified information:

1. Information on the production of fissionable material—equipment used, technology, handling, and disposition—including the technology of production of feed materials—and specifically all quantitative and qualitative output data.

2. The technology of production and power reactors, including design, operating characteristics, and working materials.

3. Information dealing with nuclear weapons and their components, including production technology, handling, disposition, testing, and technical data relating to military employment.

4. Certain information relating to the operations and facilities of the United States atomic energy program which may be of value to an enemy in sabotage planning, or in studies of the strategic vulnerability of the United States or defense potential of the United States with respect to atomic weapons.

These lists show that much scientific and technical information in the field of atomic energy is now open to those who wish to use it. There is, however, much to be done before all the requirements for the atomic energy information program are met.

WITHIN the past year the Commission, at the request of the National Military Establishment, approved a plan for distribution within the NME of certain topics of information having to do principally with the handling of the weapon by military contingents—as opposed to development and production of weapons. Restricted data of this category may be distributed within the armed forces and in their contractors organizations where needed under the degree of control necessary to assure the common defense and security by using a grade of security classification agreed upon by the Commission and the NME.

This action followed extensive discussion between the National Military Establishment and the Commission concerning the operational necessities for a broader dissemination of certain types of restricted data. This Classification Guide differentiated between two categories of restricted data: (1) those to which an individual under the jurisdiction of the National Military Establishment might not have access until he had a specific "restricted data clearance," and (2) those which the national defense requires be made available under military safeguards without specific restricted data clearance to persons under jurisdiction of the National Military Establishment. The latter category was referred to as "Type B" restricted data.

Weapons Effects Classification Board. In order to have the benefit of expert judgments on this important subject, the Commission, with the advice of the Committee of Senior Responsible Reviewers, convened as a Weapons Effects Classification Board a panel of experts on weapons-effects data to recommend the proper handling of a wide range of such data.

The Weapons Effects Classification Board urged that a considerable amount of weapons-effects data be determined to be unclassified, distributed for use in training of military personnel, and made publicly available. The Los Alamos Scientific Laboratory, in cooperation with the board and the authors, has responsibility for recommending to the Commission the contents of such a weapons-effects handbook.

Three-Nation Declassification Policy. The second International Conference on Declassification was held on September 6-9, 1948, at Harwell, England. Discussions at this conference were limited to technical knowledge held jointly by the participating nations as a result of their cooperation during the war.

Technical Information

WHILE progress was being made in classification and declassification policies and operations, a parallel advance took place in the development of the Commission's organization for handling and distributing technical information to scientists and technicians inside and outside the national atomic energy program.

Of continuing high importance is the distribution of restricted data to all those working in the project who need it and are authorized to have it. During 1948, over 3,000 individual classified reports were distributed. An average of 50 copies of each report went out.

The Commission established in 1948 a classified "Journal of Metallurgy and Ceramics of the Atomic Energy Project," issued three times each year. More such classified journals are planned.

Other technical information services supplying classified information to scientists and technicians on the project were expanded throughout 1947 and 1948. This special group of services includes a classified abstract journal which carried 2,400 abstracts of classified reports in 1948 and a classified title list which last year carried 5,500 titles of papers.

Scientists and technicians in the atomic energy program also require quick access to a wide range of declassified and unclassified papers. The Commission in 1948 established a semimonthly publication "Nuclear Science Abstracts." It is in wide demand from Government agencies, cooperating universities, research laboratories, and other institutions.

To satisfy the demand from hospitals, medical schools, and medical research institutes a special distribution to 1,200 such institutions was undertaken. The publication is available for sale on subscription basis.

The past year saw the publication of the first volume of the National

Nuclear Energy Series (formerly, Manhattan Project Technical Series), a 110-volume compilation of scientific treatises based on research carried out under the Manhattan Project. Columbia University, representing the Atomic Energy Commission, executed a contract with the McGraw-Hill Book Company to publish the 60-odd declassified volumes of this series. During 1948, 14 volumes were declassified. The first of these volumes, *The Histopathology of Irradiation from External and Internal Sources*, was put on sale in December 1948.

Of the classified volumes to be reproduced and distributed to project personnel, 24 are now at hand in the process of editing and reproduction.

Declassification continued at a steady pace during 1948. About one-third of the 900 documents declassified were for inclusion in the NNES. In addition, 870 documents were published in edited form in various scientific and engineering journals.

The Commission reproduced a number of pertinent declassified reports originating outside the project, including 96 reports from the British and Canadian atomic energy research establishments.

To acquaint the world of science and technology with the resources of technical information available through the Atomic Energy Commission, a technical information exhibit was prepared and shown at key scientific meetings during 1948.

Work with Educational Organizations

IN ORDER to provide a basis for the determination of public policy on atomic energy, there is a need for information on the operations, and the plans and prospects for the national atomic energy program insofar as these matters can be publicly reported. The Commission's public information program is based on the provision of such facts to the existing agencies of public communication—the press, the radio, schools, organized groups, and others.

Citizens also seek help in learning about the basic physical phenomena of atomic energy. This information is available from many sources other than the Commission. Organizing it and putting it into form for use in the schools and organized groups is not a prime function of the Commission. In the American tradition, this function, along with the function of presenting and discussing the issues of public policy that rise in this field belongs to the educational and information institutions of a free people.

Educational Institutions.—The Commission consults with the Interdivisional Committee of the United States Office of Education, which is developing a program of interchange of information on methods used in teaching atomic energy in schools and colleges.

The Association of Secondary School Principals and the North Central Association of Secondary Schools and Colleges have issued guides for organization of study within the secondary schools on atomic energy and its implications. Commission representatives have assisted, but the guides for use in the schools have been issued on the responsibility of these groups, and the entire projects have been financed by the groups.

At the request of the American Textbook Publishers Institute, the Commission in 1948 undertook the preparation of a Source Book on Atomic Energy for use by authors of textbooks and educators generally.

Also under preparation in 1948 was a handbook for the use of employees of the Commission and contractors. This guide will appear in three parts: (1) a primer of atomic energy facts; (2) a glossary of atomic energy terms; and (3) a description of U. S. atomic energy development.

Commission representatives are cooperating with the Social Science Research Council's Committee on the Social Implications of Technological Change by providing factual information.

Civic Organizations.—The Commission has authorized its contractors, where they desire, to provide exhibit material for civic educational purposes.

The Brookhaven National Laboratory has two special exhibits of this type which have been widely shown in eastern cities. The Ames Laboratory provided such an exhibit to the Iowa State Fair in the summer of 1948. Various of the industrial contractors constructed units portraying atomic energy program details and prospects which were assembled for the New York City Golden Jubilee Exposition. Later these units were shown in Cincinnati. These exhibit materials have been requested for an Oak Ridge educational center to be operated by the University of Tennessee Extension Service to provide educational materials for the visitors expected at Oak Ridge when the town is opened and to be used also as a facility in a Southwide public educational program to be carried on in cooperation with the Oak Ridge Institute of Nuclear Studies.

In all, attendance during the past eighteen months at exhibits for which the contractors or the Commission provided units is estimated at more than 4,000,000.

Program for Films.—The educational film-makers have been brought together by the American Council on Education to develop a program for production of teaching films on the fundamentals of atomic energy which will be available for purchase by school systems and groups.

Cooperation with Press and Radio

THE function of the press in informing the public about atomic energy is threefold—(1) in its feature services, the press (including periodicals) carries a considerable volume of explanation of the fundamental physics, chemistry, and biology of atomic energy put in lay terms; (2) in its news reporting the press chronicles the developments in the atomic energy program and outside it which have public importance; (3) in its editorial comment the press presents views to aid citizens in making up their own minds on what public policies should be.

The press calls upon the Commission organization for assistance in the first two functions. It asks for facts and for security guidance as to what may be reported and what should be withheld.

Use of Commission's review service is not compulsory. Newsmen, broadcasters, or speakers anxious, however, to be accurate and to protect the national security, are availing themselves of the service in increasing numbers.

The press is making a special effort to develop a body of newsmen trained and qualified in the facts of atomic energy so that they may do an accurate and serviceable job of reporting and interpreting. The Commission is cooperating with the Society of Newspaper Editors and is ready to cooperate similarly with other organizations of the public communications media.

Technical and business periodicals perform an important service in keeping the industrial groups informed of new developments and the possibilities they offer for cooperation of industry. The Commission has made a special effort to serve this group. During 1948 a visit to the Oak Ridge installations and the Commission offices in New York and Washington was made by a group of twenty-five editors of the leading periodicals in the metallurgical and chemical fields.

The Commission has instructed the General Manager to prepare special reports at periodic intervals throughout the year dealing with topics of special interest or for which there is a need for more detailed information.

VI. SECURITY

THE objectives of security in the Atomic Energy Commission are to assure the safekeeping of information which cannot be released without endangering the common defense and the safety of the nation and to protect the plants and installations of the Commission and its contractors from interference.

To achieve these objectives, the Commission has built up three interdependent programs: One, *personnel security*, to determine the eligibility for security clearance of all who are to have access to restricted data; a second, *physical security*, to prevent unauthorized access to installations, materials and information, and to protect such property against sabotage, espionage, and theft; and a third, *document and information control*, to systematize and enforce procedures by which classified information is withheld from unauthorized persons.

Personnel Security Program

THE Atomic Energy Act of 1946 provides that no individual shall be employed by the Commission, except in emergency situations, until the Federal Bureau of Investigation, after investigation, has reported to the Commission on his character, associations, and loyalty. It also provides for such reports in the case of those employees of contractors or licensees who are to receive access to restricted data. The Commission is then responsible for determining, on the basis of this report, that "permitting such person to have access to restricted data will not endanger the common defense or security."

During the first two years the Commission has acted on more than 100,000 candidates for clearance. The number of Commission employees is small, and the turn-over low. Also, employment among the operating contractors is relatively stable. But construction workers are being replaced continuously, and some of these must also be cleared.

Out of the more than 100,000 decisions made on employee clearance since January 1947, fewer than 2,000 have involved serious questions concerning eligibility; but the administrative burden of these decisions has been very great.

Definitive criteria for the purpose —standards of judgment which would at the same time be safe for the nation and fair to the applicant—had to grow out of experience in handling individual cases. It was therefore necessary to prepare a detailed analysis of every case that raised a new problem, in order that the decision might serve as a basis for Commission policy on later cases of the same type.

Responsibility for decisions is peculiarly grave. The Commission must determine from the reported information on character, associations, and loyalty whether the applicant or employee would be a risk to the national safety if permitted access to restricted data. In the great majority of decisions, loyalty—allegiance to the United States and belief in its form of government—is not in question. Associations have a bearing on eligibility for clearance, but the Commission must consider them only as a significant part of the information on the candidate's character. Since the candidate's character as a whole must be considered, each case presents a separate problem.

To make these analyses, the Commission employed and consulted experts with experience in investigating espionage, sabotage, and subversion, who had demonstrated their knowledge of the principles of fair procedures. A systematic catalogue was developed of the kinds of information which serve to warn that a person under investigation might be a risk to the common defense and security. In 1948, it became possible to delegate to the regional managers of operations the responsibility for screening cases—to grant clearances where no doubt existed, to refer others to Washington.

During the latter half of 1948, the Commission codified and simplified the results of its experience and, with the assistance of its distinguished Personnel Security Review Board, developed a set of definitive criteria to serve as guides for determination.

The new "Criteria for Determination of Eligibility for Security Clearance" were published in the Federal Register on January 5, 1949.[4] They are not exhaustive, but they contain the principal types of derogatory information that indicate security risk.

Category (A) includes those classes of derogatory information that establish a presumption of security risk. A candidate for clearance, for example, who has publicly or privately advocated revolution by force or violence to alter the constitutional form of the government of the United States is presumed to be a security risk if the evidence is sufficient to establish reasonable belief.

Category (B) includes those classes of derogatory information where the extent of activities—the attitude or convictions of—the individual must be weighed in determining whether a presumption of risk exists. If, for example, there is substantial evidence to prove that the individual has maintained sympathetic association with members of the Communist Party, the evidence must be carefully evaluated to determine the extent of that association and its importance.

THE Commission now handles 5,000 personnel clearance cases per month. The existence of the new criteria will increase the efficiency and speed of this operation and reduce the administrative burden, although it will necessarily continue to be great. For example, it is now possible to extend to managers of operations the authority to make decisions on clearance in the great majority of cases. Progress is being made, also, in the elimination of unnecessary requests for security clearance by resurveying and further delimiting those areas which will require security clearance.

The new criteria will also assist the Commission in dealing with the cases in which doubt as to eligibility for security clearance has been indicated by analysis of the investigative reports.

The Commission's Interim Procedure for Administrative Review, established April 15, 1948, provides for the notification to the individual of the basis for the question concerning his eligibility for security clearance, and outlines the opportunities provided him for reply and formal hearing, as well as the procedure to be followed by the AEC in finally deciding the case.

As the Fourth Semiannual Report states, the Commission is studying the desirability of granting hearings to applicants for employment who have been denied clearance.

During 1948, the Commission has received much valuable assistance and advice from the AEC Personnel Security Review Board under Chairman Roberts. The board has not only served as a board of appeal for cases acted on under the Interim Procedure for Administrative Review; it has also

[4] Reprinted in *Bulletin* V (February, 1949), 62-63.

made general recommendations on formulating standards for personnel clearance and the procedures of analysis and review. Now that it has discharged its responsibility for counsel on standards and practice, the members of the board have tendered their resignations to the Commission. It is apparent that another board of similar stature is essential to carry on the work so well begun.[5]

Physical Security

AT THE close of 1948, there were 1,270 separate plants, laboratories, offices, storage facilities, test areas, and other installations where the Commission must protect restricted information and strategically important facilities and materials. These installations represent a wide range of diverse security problems. All must be protected against unauthorized intrusion, espionage, theft, and sabotage.

In order to meet the new problems of a permanent, peacetime project, the Commission's physical security officers, in 1947, were chiefly occupied with surveying installations, taking quick emergency steps to protect those that had serious weaknesses, and planning the full-scale, long-term protection required by the national program. They examined identification procedures, studied guarding systems, picked flaws in shipment and storage methods, recommended hundreds of improvements, and set about ordering necessary equipment and construction. The close of 1948 saw most of the needed changes in effect.

During 1948, as additional insurance, AEC security and technical staffs conducted a comprehensive analysis of the sabotage vulnerability of major plants. As the result of such studies, a number of additional mechanical, electrical, and other protective devices as well as other safeguards have been installed to control and limit possible sabotage damage. Antisabotage emergency plans have been formulated at all important sites, and may be promptly placed in operation in the event of an emergency.

The kinds of protection given to the multitude of different atomic energy activities cannot be uniform in degree. Specific standards have been established to match different degrees of critical importance and vulnerability of various AEC operations. The system of standards serves as a uniform guide for determining the degree of security safeguards needed at the various types of sites.

The Commission has established a system for evaluating the status of security which incorporates the principle of independent audit to insure that adequate safeguards are maintained at all plants, laboratories, and other activities. Separate inspection units inspect and survey each installation and activity. The only function of these units is to analyze and evaluate the adequacy of security provisions at the facilities.

Some 2,500 formal security inspections and surveys were made during 1948.

The Commission has also taken steps for the emergency defense of its vital facilities against attack. To this end it collaborated with the National Military Establishment in the development of plans for the emergency military protection of its key installations, and has obtained from the Department of the Army weapons, armored vehicles, and communication and other equipment. Guard forces at major installations have been trained in the use of military equipment and in other tactical defense measures in cooperation with the armed services.

Document and Information Control

THE Atomic Energy Act states that the term "restricted data" means all data "concerning the manufacture or utilization of atomic weapons, the production of fissionable material, or the use of fissionable material in the production of power, but shall not include any data which the Commission from time to time determines may be published without adversely affecting the common defense and security." The Commission, in meeting its obligation to protect and control such data, took steps early in 1947 to establish a specific means of control of restricted data. To control classified information properly the Commission had to devise means to prevent disclosure to unauthorized persons and at the same time permit free circulation of such information among all those who need it in daily research or operation.

Specifically, this responsibility meant that the Commission had to classify large numbers of documents—Top Secret, Secret, Confidential, or Restricted—according to their importance to the national safety; devise ways of protecting them when they were transmitted, stored, reproduced, and destroyed; and maintain a system to account for their disposition. The Commission also was responsible for instructing all employees within its programs in the proper protection of classified information or restricted data and for providing cryptographic communications systems for transmission of restricted messages.

It is a task of some magnitude. Blueprints on construction that would fill trains of freight cars, miles of photographic film of the Pacific experiments, hundreds of thousands of documents recording research and development work or precise directions for operations—these are the classified data on atomic energy laboriously achieved in six years of national endeavor.

They are not inert materials that can be locked away in safe storage. To maintain the forward movement of the atomic energy project new information must be circulated through installations to all who need it. Each month approximately 10,000 documents move from one installation to another. And every month about the same number of classified documents is originated.

The Commission inherited from the Manhattan Engineer District a set of documentary and information controls and kept them in force as interim measures. The problems of a peacetime agency with widened scope of responsibility—such as that for basic research and the production of atomic power—were quite different, however, from those of an establishment working toward a single military goal. While the Commission continued its day-to-day operations it had, first, to take an inventory of all the documents it had received from MED and to revise MED regulations to fit new circumstances.

In 1948, the Commission issued a "Compilation of Security Instructions," which contained in loose-leaf form the revised working instructions on security.

The inventory of Research and Development Reports is continuing. Only after the inventory was well along was the size of the task realized. It is now estimated that the number of such classified documents—and the copies of them—will be approximately 450,000.

After examining the information of these reports during inventory, the Commission has found the opportunity to "down-grade" or completely declassify many of them and reduce the administrative burden of accounting for those reports which properly remain classified.

[5] A permanent Personnel Security Review Board was established on March 11, 1949.—Ed.

Joliot-Curie and the Atomic Secrets

(Continued from Page 110)

ington. It serves two primary purposes: to familiarize its designers and operators, under actual working conditions, with the practical engineering problems of building and maintaining a chain-reacting pile, and—more important—to supply a plentiful and energetic stream of neutrons, unavailable from any other known source. Without such neutrons the scientific experiments which are essential for further work in the field of atomic energy would be impossible. It is these further experiments which are the crux of the matter.

"The French have announced that their efforts will be devoted exclusively to research in peaceful applications of atomic energy. Taking the statement at its face value, one must also realize that, however limited the purposes of a research program may be, its accomplishments do not fall quite so readily into the proper categories. An analogy from a neighboring science may help to make the point clear: a medical research scientist may well set out, on a purely humanitarian basis, to find a cure for malaria. . . . Each item of information that he accumulates will be of immense value to a colleague whose motive is not the cure of malaria but the use of malaria as a weapon in time of war. . . .

"Once the pile begins working at its capacity, the French will be able to accumulate facts and figures which are now cloaked in the most severe secrecy. The Anglo-Saxon nations, for example, have never announced the exact number of neutrons created in the average fission of Uranium 235 or plutonium, nor the energy distribution of these neutrons, nor their distribution in time. Such knowledge is of major importance in the design of a bomb. While the Anglo-Saxons had a monopoly on chain-reacting piles, they could keep these figures secret merely by refusing to publish them. Now that the French have discovered the neutron flux, the secret is theirs for a few weeks' work.

"Thus it may be seen that the French have come into no trivial possession. How they will choose to use it remains problematical. . . . As an expression of general principle, they have said . . . that they will maintain a doctrine of free publication. But this has been qualified, and widely qualified, in recent statements by Dr. Joliot-Curie, who said that information which might be of industrial value to France will be jealously guarded. Any information which might be of direct value in armaments would be withheld until the dangers of an atomic war are laid by United Nations action, or some other form of international agreement.

"This is necessarily an entirely satisfactory statement of policy, so far as the Anglo-Saxon nations are concerned; but a more delicate inquiry would seek to determine how Dr. Joliot-Curie, as a member of the Communist Party, is likely to carry out the program he and his government have set. (It bears repeating that the government must take Dr. Joliot-Curie's own word for most of his actions, just as a patient must ordinarily take the doctor's word in matters where he alone has any pretense to competence.)

"It is a question, in short, of making a judgment of Dr. Joliot-Curie's trustworthiness, and such a judgment is an unwarranted boldness at best. It can only be said that most of those who know him have considerable respect for his acuity, his wisdom, and, above all, his love of France. It was the last of these that led him, during the Occupation, into the Communist Party. There has never been any real indication that his love for his native country runs second to his affection for Russia. It is most unlikely that his actions will be determined by an hysterical Russophilia.

"As much cannot be said with any assurance about some of his associates; and yet there is a real dilemma here. To suggest, as some have done, that the French owe it to their share in Western defense to rid their atomic energy project of Communists, is to propose that they should abandon this work altogether. It is dubious whether the French could continue without Dr. Joliot-Curie; it is certain that they could not continue without the group that would go with him. France is not likely to take such a step on its own, nor to permit such a step to be forced upon it, and it is hardly realistic to suggest it.

"The solution to the dilemma, if there is a solution, must be sought along other lines. As things stand today, France has been told to bear the responsibilities of the British, Canadians, and Americans without enjoying the real benefits of the association. The offer of a *quid pro quo* might well encourage the French to set up their own program of control and to enforce it. To those with excessively tender nervous systems, it might be well to point out that the atomic bomb itself, as an end product or as a goal, is not included in the Anglo-Saxon association and exchange of information, but remains an American secret and an American responsibility. . . .

"Until time reveals more, little further can be said about the pile at the Fort du Chatillon. That it poses problems cannot be denied. The nature of these problems is still vague—they are clear enough, however, to indicate beyond a doubt that they will not be easily solved."

Planning for Civil Defense

(Continued from Page 111)

training and information on subjects such as first aid, fire detection and prevention, detection of areas contaminated by war gases and ionizing radiation, etc., must, in the event of an emergency, take care of himself.

2. The family, which, similarly, with training, must take care of itself.

3. The community, which should organize itself to handle any emergency. If the emergency were of such proportions as to completely overwhelm the community and make it incapable of caring for itself, then the calling in of:

4. Mobile reserves set up on the basis of mutual aid. Our plan proposes the organization of mobile reserve battalions which can be moved into an overwhelmed community from various locations throughout the several states.

It is proposed that these mobile reserve battalions be organized by setting aside a certain part of the protection services in each community in the state (such as fire, police, medical, etc.) to be supplemented by volunteers in sufficient numbers to make an effective unit.

Each unit would comprise medical services, fire-fighting, rescue and debris clearance, police, radiological defense, emergency feeding, and installation and repair services.

Each unit would also have assigned to it six airplanes and twelve pilots from the Civil Air Patrol to assist in transportation, traffic control, and similar duties.

If, after the mobile reserves were called in, the community were still overwhelmed, then we believe the next step should be:

5. Military aid to civil power to operate under emergency plans that have been and are being developed. The last step then would be:

6. Martial rule. The civil defense would continue operations under military control.

Letter to the Editors

CARMEL-BY-THE-SEA, CALIFORNIA

January 2, 1949

DEAR SIRS:

In the November and December issues of the *Bulletin* are two articles which seek to prove that the dangers of the atomic bomb have been greatly exaggerated. One, by Dr. Austin M. Brues, sets out to "partially debunk" public fears of radioactivity. The second, by Dr. Bernard Brodie, announces his escape from an earlier conviction that there is no defense against the bomb. One cannot help wondering if this represents a change in the viewpoint of a majority of our atomic scientists, or if these two men (and perhaps the editors) have fallen prey to the escapism which has been characteristic of American thought ever since our program for international control of atomic energy failed of adoption.

If the articles by Doctors Brues and Brodie were convincing, one might conclude that new evidence had persuaded a majority of our scientists that their early fears had been proved unwarranted. As it is, one is inclined to believe they are not speaking for scientists as a group.

A single quotation from Dr. Brues will indicate what we mean. He says:

Chemical agents are known, in fact (and some of them may be encountered in ordinary life), which will cause genetic mutations. Cancer can be made more likely to occur by radiation exposure, but exposure to sunlight will also increase one's chances of skin cancer. Total body radiation exposure will shorten the life span, but tobacco smoking is another way to accomplish this result.

One can imagine Dr. Brues sunning himself on the beach, smoking a cigarette, then repairing to the Argonne Laboratory to get himself a "total body radiation exposure"! Doubtless the 10,000 people who died from radiation exposure at Hiroshima were mistaken in believing that something more dangerous than suntan and tobacco carried them off. And the Navy obviously did not sink the target ships of Bikini because their decks were impregnated with sunshine and nicotine.

Dr. Brodie's article requires more careful analysis, but his evidence is no more convincing. He says,

It has been argued by some (including the present writer) that it was in the very nature of atomic armaments that the kind of clear and decisive military superiority that was feasible in the past—conspicuously in the case of naval armaments—could no longer be realized. The argument was based fundamentally on two considerations: first, that there was "no defense against the atomic bomb," and second, that when a nation had enough bombs to overwhelm its opponent in one surprise attack and was willing to make such an attack, it would make little difference whether its opponent had two or three times the number. . . . There is now reason to believe that the situation is not as simple as all that.

Dr. Brodie then questions if the Soviet Union can make enough bombs to carry out a decisive attack upon the United States. He also feels confident that we need not greatly fear atomic bombs because of our continuing superiority in aircraft and antiaircraft devices.

Dr. Brodie's evidence that the Russians will not be able to make enough bombs, consists of the following:

Information which would enable private citizens to make intelligent estimates concerning the rate of bomb production has not been made public, but there appear to be hints in various quarters that the feasible rate of bomb production is substantially less than was generally assumed two years ago. It is also clear that the richer of the known deposits of uranium and thorium are much more accessible to the United States than to the Soviet Union.

Just about the time that Dr. Brodie's article was on the press, Chairman David Lilienthal, of the Atomic Energy Commission, decried the efforts of "some military men and some scientists" to "play down" the atom bomb. There was, he said, "no shortage of uranium."

A year ago the President's Air Policy Committee, presumably after examination of all inside information, estimated that the Soviet Union would be making atomic bombs "in quantity" by 1952. Later this estimate was used by the Army General Staff, in discussing United States strategy in the years ahead. It is not clear how many years of production "in quantity" will be needed for the Russians to acquire enough bombs to make a decisive attack upon our country, but one would gather that ten years, or less, of such production would suffice. If bombs become more powerful, fewer will be needed and the critical time will be brought nearer. Dr. Brodie agrees, in another portion of his talk, that present bombs are many times more powerful than the Hiroshima bomb.

The evidence Dr. Brodie offers in support of his second contention is even less convincing. "The bomb itself," he says, "has no military value. It must be delivered to the target. . . . Our lead in types of aircraft, in ordnance of combat aviation, and in anti-aircraft material should, or could, be as great during the next twenty years as it was during the war."

Certainly the bomb has no utility unless it is taken to its target. And there is every reason to believe we can maintain our present outstanding superiority in aircraft. But there agreement with Dr. Brodie's position ends. What he fails to recognize is that the surest way to place a bomb where it will be most destructive is to put it there through the use of human hands. And the most certain way to explode it at the moment when it will do the most damage is to use time-detonators. He seems to forget that an assembled bomb is the size of a piano, its explosive element is the size of a watermelon and its explosive material can be carried in the ink compartments of fountain pens. The atomic bomb has given the saboteur his perfect weapon. Through its use, two hundred men, in another war, can do more damage than two million men did in World War II.

General Lucius Groves says that our greatest danger is from bombs "smuggled into the country in parts in suitcases." One wonders, if this is so, just what superiority in aircraft has to do with our risk, and why Dr. Brodie failed even to mention smuggled bombs?

One of our greatest dangers escapes Dr. Brodie's notice. This is from bombs planted along our coastlines by submarines or merchant ships, and exploded under water when strong inland winds are blowing.

A year ago, during "Atomic Energy Week" on the Monterey Peninsula in California, Dr. David Bradley, Bikini radiologist, stated that a single Bikini-type bomb, exploded in San Francisco Harbor, would make the whole Bay Area uninhabitable for at least a lifetime. Los Alamos Atomic Physicist W. Bradford Shank said that six modern bombs, placed at proper intervals along the Pacific Coast, and detonated when a strong inland wind was blowing, would make the area west of the mountains

unsafe for at least a century. And Robert D. Miller, Chief Electrical Engineer of the San Francisco Navy Yard and official Navy observer at Bikini, stated that it would be easy for a hostile nation to plant bombs along our coastlines by submarines and detonate them when conditions were right, by remote control.

How can anyone discuss atomic dangers and give no mention of this form of attack?

If the Russians have any sense of military strategy (and they exhibited a substantial amount in the recent war), they unquestionably have considered the probable effect of simultaneous use of these methods of attack:

1. Destruction of our two hundred leading cities by smuggled bombs, to wreck the industrial capacity needed to carry on a modern war.

2. Drenching our coastlines and port cities with radioactivity, to make it difficult if not impossible to launch expeditionary forces across the oceans by water.

3. Atom bombing of the outposts, surrounding Russia, planned for use in our counterattack.

4. Awaiting our long-range bombers with jet-propelled fighter planes.

The "swift retaliation" which we are counting on to deter the Russians from attacking us might, after such a coordinated surprise attack, prove to be a badly blunted instrument. It is not at all certain that we could rally ourselves enough thereafter to win the war. The only sure thing is that we would suffer unbelievable destruction.

Instead of welcoming to its pages such unconvincing efforts to minimize the dangers of the bomb, as those of Doctors Brues and Brodie, the *Bulletin of the Atomic Scientists* will do well to go back to the practice of printing in large, black type, "There is no defense against the atom bomb." For instead of becoming less dangerous, the atom bomb is much more powerful than it was at the war's end. And techniques for its use have become much more deadly. We shall fail ourselves and the world if we minimize the destruction of atomic war, and abandon our efforts to establish international control and a world government with enough power to insure peace.

ZENAS L. POTTER

ERRATUM

The Bulletin wishes to correct a typographical error in Dr. Oppenheimer's article in the January issue. On page 5, column 1, for "imminent" read "immanent."

BOOKS

No Place to Hide. By DAVID BRADLEY. New York: Little, Brown, 1948. Pp. 182. $2.00.

THIS book is the brilliantly written log of a young surgeon who received his baptism in atomic energy as a member of one of the Bikini monitoring crews. As such, it is a vivid descriptive chronology of an experience shared by many other intelligent men as they witnessed the Bikini blast. Interwoven with this is an equally clear panorama of a series of emotional experiences such as few doctors are gifted to put down.

One wonders how to assess the great and immediate public response to this book. Although the title and style are not such as to deny the book popularity, it must likewise be true that the subject of the atomic bomb is still one which captures popular imagination. Let it not be said soon again that people have become tired of hearing about it. On top of this, we have a dramatization of radioactivity and decontamination, subjects which have been too little discussed.

It is exactly in this last field that the book leaves something to be desired. Dr. Bradley is rightly censorious about the relative lack of emphasis on radioactive contamination as a result of bombs set off otherwise than at Hiroshima and Nagasaki. Through the book, however, runs a thread of argument suggesting that now, at last, in radioactivity we have something which is truly and completely intolerable.

One can, of course, point out that radioactivity is intolerable only in large enough amounts, or that there are some other things which can be intolerable too, and which may be deposited on our doorstep if the world doesn't get some wisdom. The doctor does say some of these things, but they seem to have been snowed under by the interest of reviewers in other things—that contamination of the hand is treated by removal of the arm (not so); that each click is a little bullet shooting through the body (try listening to the machine-gun barrage created by your watch dial).

The writer of this review has had the unhappy experience of trying to say some of the things alluded to above, only to find himself accepted as a proponent of the thesis that "radioactivity isn't so bad, after all," or "why worry about it?"

There is plenty of reason to worry about it, but this is the inevitable result of the two-valued orientation which people seem to have to questions both old and new—a thing has to be good or bad; either we had best run away and hide in caves, or else it is O.K., why do anything about it?

People obviously need to learn some semantics as well as nuclear physics; data aren't enough to save the world from some very unpleasant times ahead. The two-valued orientation is beautifully depicted in a discussion between the Doc and a cleanup crew, at the end of chapter "Baker Day":

"Doc," he asked, "what about the six fellows?" . . . .

"You probably are thinking about the men who were killed at Los Alamos. . . . They were well-trained scientists working with extremely dangerous stuff. What we have spread out over twenty-five miles, they were working with in one room."

"Well, if nobody is getting hurt, Doc, why do we bother with all this damn scrubbin'? . . . . Why don't we just get steam up on these buckets and haul out of here before we rot and sink at our chains?"

"I'll tell you, Chief. It is because even this amount of stuff is dangerous. For two reasons: first, it doesn't take much to kill you. If this stuff were all radium and you got a piece no bigger than a grain of salt inside you, you'd be a goner. Fortunately, most of the fission products aren't quite that bad—or we'd all be goners by now. And the second reason why we are so darned careful is that there is a lot of stuff out here we don't know about, stuff that can't be picked up on a Geiger machine. Some of that material is plenty dangerous."

I labor this point only because I can see the danger of an Orson Welles-like panic if people become only partly informed on the subject.

Some of my scientific colleagues point out that the Appendix leaves something to be desired. It is true that some changes could be suggested. Perhaps the most humorless objection has been to the use of word "Geiger" as synonymous with "disintegration measured on a counter." For myself, I think this is a beautiful addition to colloquial English.

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